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Opposite views on engine stripping

There are at least two clearly defined and opposite views regarding the extent to which locomotives should be stripped or dismantled when received at the back shop for heavy repairs. Briefly stated, one of these is that a locomotive, having made the full required mileage between general shoppings, deserves complete inspection and overhauling in every detail in order to assure a minimum of expense and delay for running repairs at enginehouses during the next period of road service. One railroad which adheres to this idea and has an enviable reputation for the condition of its power, presses out every crank pin on a general repair locomotive, turns and rolls it (if within the shop limits of size) and presses it back in the wheel center. Every main driving journal is turned and rolled irrespective of whether it is worn tapered or straight, rough or smooth.

Those who take the opposite position advocate as little stripping as may be necessary to get at parts which are worn and need repairs, and as little machine work on the parts so removed as is essential to good practice. They do not advocate slip-shod methods or poor workmanship, but they do say that certain parts of a locomotive need not be removed in order to give the locomotive a thorough overhauling and that all of this work of stripping, machining and replacing which is saved, represents so much clear gain and has a very desirable effect in reducing shop costs. Proponents of this idea have in one case gone so far as to require the erecting gang foreman or his head machinist to supervise the stripping to make sure that no parts shall be removed which are in sufficiently good condition to be within the established limits of wear permissible on locomotives going out of the shop.

The extent to which locomotives should be stripped for general repairs in the back shop certainly is a vital subject, about which it is possible for fair-minded men to disagree. No one will attempt to justify inferior workmanship but there is a difference of opinion regarding the advisability of stripping the locomotives to the ground for general repairs or leaving in place certain parts which appear to have little or no wear. The chances are that one of these practices has more merit than the other, and it is highly important that the railroads as a whole follow the better practice of the two because large expenditures for maintenance are involved.

The *Railway Mechanical Engineer* would like to bring out the ideas of its readers on this subject and thus assist in arriving at an intelligent basis for a solution of the problem. Mr. Shop Officer, if you are following one of these plans or the other, write and tell us why. Describe your practice in simple, straightforward language, explaining its advantages and the results secured. Mr. Master Mechanic and Mr. Roundhouse Foreman, tell us how locomotives repaired by these two methods are performing on the road. Your letter or article need not be long and don't worry if a few punctuation marks are missing. Anyone can supply them. What the world needs is ideas. Let the railroads have yours.

Fuel economy at engine terminals

C. J. Beshears, writing in the July Frisco Employees' Magazine, calls attention to the fact that the cost of terminal fuel forms an important part of the railroads' coal bill and points out in a striking way the important economies which can be effected by banking locomotive fires properly at terminals. A few months ago Locomotive 326, a small 2-6-0 engine belonging to the St. Louis-San Francisco, was reported held under fire for 78 hours at Fort Scott, Kan., on 26 scoops of coal or approximately 390 lb., and the same coal was used in spreading the fire and making the engine ready for service. Another test made subsequently with a locomotive having 50 sq. ft. of grate area demonstrated the possibility of holding a fire 11 to 12 hours on 25 to 30 scoops of coal, or approximately 450 lb. In view of the size of the railroad coal bill, every effort should be made to minimize coal consumption in the various branches of service. Isolated power plants at small shops and engine terminals offer a fine opportunity for coal saving in many instances and this question of saving by proper banking of locomotive fires is only one example of what can be done.

The initial step in saving locomotive fuel at engine terminals is to see that locomotives come to the terminals with light fires in as good condition for cleaning as possible considering the kind of coal used. Otherwise good fuel must be wasted in the cleaning operation. A few shovels of coal can be spread evenly over the firebox in case additional steam is required for testing appliances but this testing should be done at once and as nearly as practicable at one time so that it will not be necessary to disturb the bank later. The main idea is to use the steam pressure on the locomotive in storing water in the boiler after the fire is cleaned and then bank the fire in such a way as to prevent the coal from burning out and permit its subsequent use in raising steam pressure. If 80 or 100 lb. of steam must be kept on the locomotive for occasional movements, coal has to be applied nearly every hour and the injector worked, which wastes fuel. Some railroads have found smokstack covers a great aid in preventing the creation of draft and consequent combustion of fuel.

Firing up engines is also a considerable item of terminal fuel expense and in another test on the Frisco at Chaffee, Mo., as reported in the article mentioned, it was demonstrated that a 1300 class locomotive with 50 sq. ft. of grate area can be fired up with 45 scoops of

Illinois run of mine coal, one 15-lb. scoop of coal per square foot of grate area being found to give a fuel bed four inches in depth.

More knowledge is required of master blacksmiths

New developments in machine tools and shop equipment have had a revolutionary effect on the work of practically all crafts employed in railroad shop work. These developments have, as a rule, tended to eliminate the need for skilled craftsmen to such an extent that a great many jobs formerly the handiwork of a trained mechanic are now performed by a machine which is operated by a man having only a few months' experience. Undoubtedly, the blacksmiths more than any other craft, have been required to change their methods and practices due to new developments in their work. Developments in forging machinery, welding and heat treatment have not only caused reductions in blacksmith shop forces, but these developments have achieved increased production with better uniformity in quality and workmanship. Any one familiar with the work done in a railroad blacksmith shop knows the amount and variety of work that can be turned out on a modern bulldozer or forging machine as compared to the old method of hand forge and anvil. These developments have tended to make blacksmith shop foremen close students of production methods and this tendency is perhaps indicated by the large number of dies, jigs and fixtures designed to facilitate production which were shown at the 1925 convention of the International Railroad Master Blacksmiths' Association. But quantity production is worthless without quality and the latter is only obtained by knowledge of *how* the work should be done.

Knowledge of production methods is not all that is required of the present day railroad blacksmith shop foreman. The past ten years has been a period of remarkable progress in the arts and sciences directly related to the blacksmiths' craft. Chemistry, metallurgy and mechanical and electrical engineering have all contributed something to its development. Few master blacksmiths have the time or the opportunity to study to become experts in the theory of the various welding processes and the heat treatment of steel, but they must be experts in their practical application.

The ability to make practical applications, however, does require some knowledge of the theory of the various processes mentioned. This knowledge can only be obtained from those who have made a special study of the subject and who have become experts in their respective professions. It is unfortunate that the Blacksmiths' Association has not seen fit to invite experts in the various technical professions related to the craft to present papers at its conventions. Quite a number of railroad associations have taken cognizance of the fact that they must go to all sources of information in order to obtain complete knowledge and facts pertaining to their field. The experience of these associations has shown that such a policy has been beneficial to the members and has also made the printed proceedings a valuable reference book, as information from all sources is contained therein. It is to be noted that papers presented by experts employed by railway supply manufacturers are prepared on an engineering and not on a propaganda basis, and are invaluable contributions to the influence of the associations.

It is essential that the master blacksmiths-work in close co-operation with the technical professions with the object of keeping in touch with developments that have practical shop applications. The International Railroad Master Blacksmiths' Association has already done considerable work along this line but there is still much to be done towards clearing up misunderstandings on the part of both the craft and the supply manufacturers. In this the association should request the support of both the railroad and railway supply industries.

Accurate data for locomotive improvements

Before any successful locomotive can be built, the designer must have complete knowledge of the conditions under which it is to be operated—weight of rail, layout of road as to grade and curvature, weight and character of trains to be hauled and running speeds. Without this knowledge there would be no way to insure the ability to meet traffic conditions. All these factors, however, can be determined in advance with comparative ease. Success of the design depends also upon reliability of performance in service, freedom from breakdowns and the need of either frequent adjustments or minor repairs. These demands can be met by a knowledge of materials, calculations of stresses, with a sufficient allowance for the unknown, and a knowledge of the performance of detail parts on similar locomotives.

Engine failures and maintenance costs are watched sharply by other departments as well as by the mechanical department. Then, the engineman and fireman must be thought of and due consideration given to the cab layout and the selection and location of fixtures and piping for convenience of access. This may seem to be of somewhat minor importance and, while the examination of locomotive cabs frequently leads one to the conclusion that a little more time and study might well have been given by the designer to the details of cab design, much more thought is being given to these points than was formerly the case. Here, again, knowledge which can best be gained by riding engines is most valuable to the designer. Mention might be made of many other details of construction where data, both theoretical and that gained from practical experience, is essential to the working out of a complete and successful design.

The places where present interest is the greatest and where there is the largest field for further development are found in these parts of the boiler and engine which have to do with overall thermal efficiency. A successful design of a locomotive, as the term is beginning to be generally accepted today, implies the production of a transportation machine that is economical in its fuel and water consumption as well as one that can be depended upon to get the trains over the road on time and can also be maintained without too much attention or too great expenditures for labor and material.

Unfortunately, the data on which the designer has to rely in order to obtain the maximum drawbar horsepower per pound of fuel are by no means as well known or as accurate as are the data available for other points of design. For the securing of greatly needed data it is essential that many locomotive tests be carefully conducted—tests with a dynamometer car in actual train handling on the road and then tests on a fixed testing plant. The changes in boilers, with modifications in design, proportions and steam pressures, together with the modifications in cylinder arrangement, valve gears and the re-introduction of compounding all make the need of proper tests of far greater importance than heretofore. The conducting of such tests might well be a function of the Mechanical Division of the A. R. A., as all roads would benefit by the data obtained. This is, moreover, but following a precedent

established in the undertaking of power brakes, truck frames and draft gear tests. However, without waiting for such action, a number of the more important railroads which do not now possess dynamometer cars, would find that the money spent for their purchase would yield big returns and aid them in securing much more efficient motive power.

Mechanical department employees and the public

A railroad or other public utility must cultivate the public which it serves. American railways know only too well what the displeasure of the public means—indeed we may go much further and say that severe and unnecessary restrictions and handicaps have frequently been placed upon the railways by representatives of the public because the citizens in general have not been fully or correctly informed as to the facts about the railroads and the extent to which the interests of the public and the railroads are mutual. Much, however, has been done in recent years to educate the public in these respects, so much so that there has been a radical change in the attitude of the public towards the railroads.

One important factor affecting the relations between the railways and the public must ever be kept in mind. The public judges a railroad not only by the character of the service rendered, but by its employees—their personalities and actions and their attitude toward both the public and their employers. While few of the mechanical department employees come in direct contact with the public in the performance of their duties, nevertheless they are regarded as representatives of the railroad, and a part of it, in the eyes of their neighbors and fellow citizens. If an employee who depends on the railroad for his livelihood cannot talk intelligently about it and its needs to his friends, or if he is constantly criticizing the management and does not boost the road, or if he is an indifferent and unintelligent citizen, it is a reflection upon the road in the eyes of those with whom he comes in contact, whether he is on or off duty.

Because a railroad is a public service institution and because so much depends on its scope and efficient operation, the employees who are well paid in comparison with workers in other fields and industries should be above the average. Is it not obvious also that railway workers should not only be thoroughly trained and coached in the performance of their duties, but that they should be posted as to the facts about their railroad and its operation and the more simple and fundamental principles of the economics of transportation? Should they not also be encouraged to take a real interest in public questions and the welfare of the communities in which they live? Many of them now do this, but is it not true that far too large a proportion are more or less indifferent to these things?

There are, of course, many ways in which this problem can be approached, but only one avenue will be here considered—that of the selection and training of new employees, particularly the younger ones. It is significant that not a few railway officers are now giving special attention to the recruiting of their forces. No longer are they standing back waiting for the young men to approach them for jobs, but they are actively searching for the best boys who may be available in their districts in the near future. It can safely be said that the relations between railway officers and school superintendents and high school principals are far more intimate in general than they were a decade ago, or even five years ago. Then too it is quite surprising to see how many mechanical departments have faced seriously the importance of the right kind of apprentice training. The Santa Fe, which has so long led the procession—for a time it was mostly leader and little if any procession—will have to look to its laurels if it is to retain its leadership. It is significant also that so large a proportion of the apprentice supervisors and instructors are impressed with a responsibility of the moral and citizenship training of the apprentices. At the same time the government through its vocational training agencies is assisting in the technical training of the apprentices on some railroads, and is evidently prepared to render still wider service if called on to do so.

This is all well and good, but how about the army of clerks, messengers, etc., in the mechanical department? Is it not just as important that the training and development of these young men should be given some attention on the part of the management? Do these neglected groups not offer a real opportunity? What might it not mean if these young men were more carefully selected with a view to their future development and usefulness? What might it not mean to the railroad if greater thought and study were given to coaching and training them in order that they could render more intelligent and efficient service to the mutual advantage of themselves and the railroad? What might it not mean in the way of inspiration if they had a better understanding of the importance of the railroad from the economic, political and social viewpoint? It may be difficult to devise ways and means of remedying these shortcomings, but will not the effort or expense involved be well worth while?

New Books

RAILWAY TRACK AND MAINTENANCE. *By E. E. Russell Tratman, associate editor, Engineering News-Record, 490 pages, 6 in. by 9 in. Bound in cloth. Published by McGraw-Hill Book Company, 370 Seventh avenue, New York. Price* $5.

Anyone who undertakes to write a book on a subject of as broad a scope as that implied by the title of this work is confronted with two alternatives—to prepare an exhaustive treatment covering certain restricted phases of the subject in minute detail or to cover the subject from all angles, including related matters which may be deemed to have some bearing on the main topic. In Railway Track and Maintenance the author has adopted the second of these two ideas to an extent which indicates that his primary appeal is to the student or to the young man entering the railway service who must gather as quickly as possible a general knowledge of railroading insofar as it relates to his duties in railway engineering or maintenance of way work. If this was the author's intention he has succeeded, for there is little which has to do with railway track and its maintenance which has not been touched upon in some form.

The book opens with an introductory chapter on the general nature of track and its maintenance, followed by chapters dealing with roadbed and ballast, ties, rail, fastenings, etc., and other physical features of the fixed property, including brief reference to water and coal facilities, cinder disposal, yards and terminals, passenger stations, etc. The second half of the book carries the sub-title "Maintenance Work and Economics" and deals with organization and methods covering not only track maintenance but also "bridge work and telegraph work," "signals," "improvements and betterments," "emergency work," "records, reports and accounts," etc. Frequent reference is made to the work of the American Railway Engineering Association and to the standards and practices of specific railroads.

Combustion efficiency in locomotive boilers

Losses in unburnt fuel, radiant and convection heat, and tube lengths important factors

By Louis A. Rehfuss

AT moderate speeds and at slow rates of firing, the modern steam locomotive is an efficient combustion machine. With the demand for more power within the limited dimensions available, however, a different story is told. It has become customary to design locomotives to deliver their rated tractive force when burning 120 lb. of coal per sq. ft. of grate per hour, a rate not approached in stationary practice.

What this forcing of the fires does to our combustion efficiency may be shown by the following table, approximated by the writer from published test results, giving the disposition of the coal actually fired:

Rate of firing, coal per sq. ft. of grate per hour	50 lb.	100 lb.	125 lb.	150 lb.
Utilized in evaporation, per cent	70.8	62.5	56.0	51.0
Loss in unburnt fuel, per cent	10.0	19.0	26.0	34.5
Outside losses (radiation), per cent	3.5	3.5	3.5	2.5
Carbon monoxide losses, per cent	0.7	1.0	1.1	1.0
Smokebox gases, per cent	15.0	14.0	12.4	11.0

With the losses in smokebox gases and by radiation, we are not primarily concerned, since these are not losses to be traced to inefficiency of combustion. On the other hand the losses in unburnt fuel are serious and it is with these that we would treat. It is evident that no power plant that allows 25 to 30 per cent of the fuel fed to it to pass out unconsumed can be called efficient.

The rules for complete combustion are well known and comparatively simple, although not always so easy to apply:

1—The fuel must be intimately mixed with the required amount of air.

2—The temperature necessary for complete combustion must be maintained a sufficiently long period of time to obtain the required chemical combinations.

3—The human element in firing must be carefully taught.

From the care practiced in taking test plant data, we can hardly lay the blame on the third element. The fault must lie in the design of the locomotive boiler itself, and in its inadaptability to the high rates of firing to which it is subjected.

These losses in unburnt fuel, aside from that left in the ashes, are comprised principally of sparks, cinders and small particles of carbon released by the breaking up of the coal from the heat of the fire. The powerful draft used at high rates of firing sweeps these out of the firebox so swiftly that they do not have time to burn, or even to mix intimately with the air supply. As soon as the gases strike the small bore fire tubes their temperature is quickly reduced to a point where the unconsumed carbon particles are free to pursue their course up the stack unburnt. The comparatively small combustion space of the customary locomotive facilitates this action. The intermittent and explosive action of the exhaust contributes to this end, since its pulsating character acts as a jerk on the fire. All of these influences make it difficult to obey the two primary laws of combustion.

The American railroad man recognizes these conditions, but in his desire for maximum power from given engine units he has been forced to compromise at the expense of fuel economy. Of late years the conservation of fuel has been given more attention and some solution must be found for this problem. Particularly is this so when the trend of the times clearly demands more and more power, enhancing that forcing of the fires which creates the condition at issue. For this reason a discussion that has been going on for some time in the engineering world on radiant heat is of timely interest.

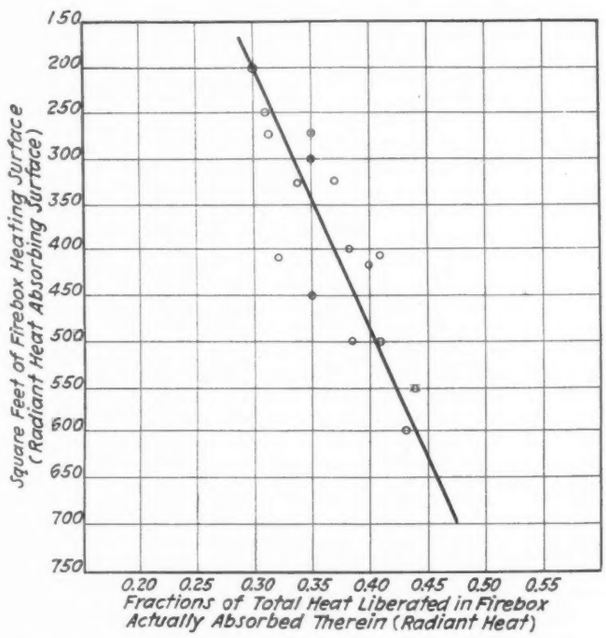


Fig. 1—Variation of radiant heat absorption in the firebox burning 6,000 lb. of coal per hour

Radiant heat defined

In the production of heat by combustion we release several kinds of heat. Radiant heat is the heat transmitted from one body to another separated from it without giving up any heat to the gases that may lie between. The heat we receive from the sun is of this nature. Convection heat, on the other hand, is transmitted by contact, as of one gas particle to another, or by gas particles striking tube walls.

The swifter the gases are swept along a given metal surface, such as a tube, the greater will be the convection heat absorption therefrom for a given tube surface area. The smaller the bore the swifter must be the flow to enable a given volume of gases to pass through. This is the explanation of the high evaporation rates possible on locomotive boilers at high rates of firing. Unfortu-

nately this does not help the combustion, as the gases are chilled too quickly to consume the unburnt fuel particles.

Radiant heat, on the other hand, does not depend for its absorption on speed of flow, but rather the reverse. In the locomotive boiler a large part of this radiant heat is absorbed by the firebox, but not all. It becomes important, then, to determine the percentage of radiant and convection heat on which we may rely.

The formula known as the Stefan-Boltzmann law is generally accepted by engineers, which shows that the radiation proceeding from a hot body is proportional to the fourth power of the difference of the absolute temperatures. Broido, Orrok and others have made this the basis of a simplified method of determining what fraction of the total heat liberated in the furnace will be absorbed by radiation. From data given in their recent papers (published in Mechanical Engineering, February and March 1926), and not confined to any one type of boiler, the writer has drawn Fig. 1, to show how the proportion of radiant heat absorption in the fire box varies with the amount of evaporative surface provided.

Thus, for 300 sq. ft. of surface, where coal is burned at the rate of 6,000 lb. per hour, this fraction will be about .35, while with 500 sq. ft. of firebox surface it would rise to .42. The ability to obtain this large percentage of the total liberated heat by absorption in the firebox without chilling the fire and reducing the efficiency of combustion itself, of course depends on an increase in the firebox volumes commensurate with the increase in firebox surface.

The balance of the heat, say 60 to 65 per cent, part of which finally is lost with the smokebox gases, enters the tubes. It has been the custom heretofore to regard all heat absorbed by the firebox as radiant heat received directly from the fire, while the heat left in the gases as they entered the tubes was considered only convection heat, so that it was considered correct to speed the gases at once down small bore tubes. This is not the case. Not only does the firebox heat absorption contain some convection heat absorption, but the gases themselves radiate heat in the tubes to a degree hitherto little suspected.

It was long known that for every drop of one degree in temperature of the gases at high temperatures much more heat was transmitted than for an equal drop of one degree at lower temperatures, but the explanation was not forthcoming. It is now shown that the gases themselves, or rather the carbon dioxide and hydrogen elements thereof, emit considerable radiant heat at high temperatures, and therefore must be regarded as following the Stefan-Boltzmann law much as does the radiant heat from the solid fuel particles of the fire in the furnace itself. This means that the hot gases as they enter the tubes possess a very high degree of radiant heat, which decreases rapidly as the gases cool down. Thus, in an example given by Broido (Mechanical Engineering, February, 1926), of a stationary water tube boiler, the gases in their passage over the tubes transmitted the following percentages of radiant and convection heat:

	Radiant heat	Convection heat
At 800 deg. gas temp	14.8 per cent	85.3 per cent
At 1,600 deg. gas temp	23.7 per cent	76.3 per cent

By applying the Stefan-Boltzmann law to the same data for greater temperature ranges under the same conditions, the writer derives the following ratios of heat transmitted:

	Radiant heat	Convection heat
At 2,000 deg. gas temp	37.2 per cent	62.3 per cent
At 600 deg. gas temp	12.0 per cent	88.0 per cent

Broido draws the conclusion rightfully from these facts that, as the heat transmitted by convection varies with the speed of the gases while radiant heat from gases is more effective at slower speeds, it is urgent to have high gas velocity only where the convection heat is strongly predominating. In other words, in the furnace itself as well as in the early tubes stretches, where the radiant heat is strong, boiler efficiency does not demand high gas velocities to attain satisfactory evaporation and it is only in the latter tube stretches where convection heat is markedly predominating, that unusually high gas velocities must be employed.

Tube lengths and evaporation

These conclusions are important in throwing new light on the whole question of combustion vs. evaporative efficiency. The high losses in unburnt fuel are primarily due to the fact that locomotive boilers have been so overloaded with tubes and tube area in striving for maximum evaporation that little room has been left for adequate combustion at the high gas velocities employed. Firebox volumes sufficient for slow firing rates prove totally inadequate at the higher firing rates and the gases are swept into the tubes too fast for complete combustion. Once in the tubes not only is the gas velocity speeded so much the more because of the restricted area available, but half of the total temperature drop along the tubes occurs in the first 25 per cent of their length. Hence, all further combustion ceases.

It would seem evident from these considerations that instead of having 20-ft. tubes and a 4-ft. combustion chamber, better results would be obtained were the tubes cut to 12 or 14 ft. in length and the additional six or eight feet added to the combustion chamber.

Experiment has shown that the first 12-ft of a 20 ft. locomotive tube causes approximately 79 per cent of the total temperature drop along the tube. When the higher specific heat of the gases at the higher temperatures is taken into account, this would mean that roughly 85 per cent of the total heat transmitted by the gases in their passage through the tubes is given up in the first 12 ft. of their length.

To collect the other 15 per cent when using shorter tubes would simply be a case of employing smaller bore tubes and thus reducing the hydraulic depth. Thus, for an initial temperature of 2,000 deg. the resulting smokebox temperature for a 20-ft. flue of 2¼ in. outside diameter and a given speed of gas flow would be about 560 or 580 deg. Suppose now we use tubes of 1½ in. outside diameter, and increase the number of tubes accordingly as permitted by the tube sheet area for the smaller bore tubes employed to take care of the same gas flow. Employing the formulas developed by Lawford Fry and others for temperature drops along tubes, it can be shown that tubes only 12 ft. long in the latter case will develop smokebox temperatures only 20 or 30 deg. in excess of the larger bore 20-ft. tubes used in the first instance. As a matter of fact the increased heat absorption in the larger combustion chamber should relieve the tubes of part of their burden, so that no appreciable difference should be noticed in the smokebox temperature.

Such small bore tubes, because of their shorter length, should give no more trouble in maintenance than the larger bore but longer tubes used today.

By adding the eight feet thus saved to the combustion chamber, a marked betterment in combustion efficiency should result. The unburned fuel particles would travel in the high temperature zone a sufficient length of time to become intimately mixed with the needed air, and to maintain their temperature long enough for more nearly complete combustion.

Of course it is realized that such a course would require changes in construction details of the first magnitude, particularly where a staybolted design were used. It is hardly likely, however, that staybolted designs will

continue to enjoy the same pre-eminence that they have in the past. It is not natural to hold pressures with flat surfaces. Watertube constructions are more apt to be trend of tomorrow. With these it should be possible to construct a zone of combustion varying gradually from the open areas of the firebox through widely spaced tubes in a long combustion chamber until the gases finally pass a dense tube nest before emerging into the smokebox. With such a design the widely variant nature of the heat from predominatingly radiant to predominatingly convection would be accommodated without interference with the completion of combustion itself.

Means of improving combustion efficiency

Other expedients besides the extension of the combustion space are of course possible for improving combustion efficiency and may be here briefly reviewed.

Increasing the grate area.—This reduces the rate of firing and the velocity with which the air passes through the fire, consequently lessening the tendency for unburnt coal particles to be wafted off with the gases. That locomotive designers appreciate this factor is seen in the ever increasing size of the grates, made possible of course by the use of stokers.

Increase in the cylinder ratios.—Aside from their beneficial effect in securing more even starting torque, an increase in the customary number of cylinders and a change in the angular ratio of the crank pins are recommended as benefiting combustion by reducing the pulsating character of the exhaust.

The writer is inclined to think that the harm done by the intermittent exhaust action, except at slow speeds, has been overrated and that it plays but a minor part in combustion losses compared with the excessive velocity of the gases through the firebox. When it is considered that a two cylinder locomotive will give four impulses per revolution or approximately sixteen per second at normal speeds it does not seem likely that the intermittency of this action will make itself felt as far back as the firebox, where it will assume more the proportions of a steady suction.

Fan draft.—The use of a fan draft would do away with the pulsating nature of the exhaust and produce a steady suction, but the remarks made in the paragraph above apply here as well. Fan draft has been tried on locomotives, but has failed of mechanical success because of the installation of fans totally inadequate for the volume of gases they had to handle.

Firebrick arches.—Arches have come into general use as an assistance in prolonging the path of combustion and are too well known to require further comment. Few locomotives are now built without them.

Preheated air.—In the effort to get more power, locomotives are sometimes driven to burn 150 to 175 lb. of coal per sq. ft. of grate per hour. It is found that not enough air can be sucked through the ordinary grate to attain this firing rate, so the firedoor is opened to admit the extra air found necessary. The draft suction then pulls this air on the shortest line from the door to the tubes, from *A* to *B* as shown in Fig. 2. Such air is in contact with the fuel particles a comparatively short time, and chills them below the temperature of combustion. It is not surprising that the unburnt fuel loss mounts up so rapidly, as a consequence, to 35 per cent of the total fuel fired.

The remedy for this condition would be in the use of preheated air admitted not at the door but just above the fire in the front waterleg as shown in Fig. 2, so that it would have to traverse the length of the firebox under the arch and around to get to the tubes. This would insure thorough mixing with the fuel particles in the gases and maintain them in an oxygenated atmosphere of the required temperature long enough for complete combustion.

The Ljungstrom Turbo-condensing locomotive built in Sweden has an interesting air-preheating feature. A series of air tubes runs from the front of the engine underneath the boiler to an enclosed ashpan. The velocity of the locomotive causes air to rush down these tubes at a speed which is regulated by a shutter control. The smokebox gases circulate around these tubes and preheat all air admitted to the ashpan.

Waste heat in the form of smokebox gases, exhaust steam or hollow jackets surrounding the boiler may be utilized for moderate preheating, but the writer believes that the day may come when preheating the air will be

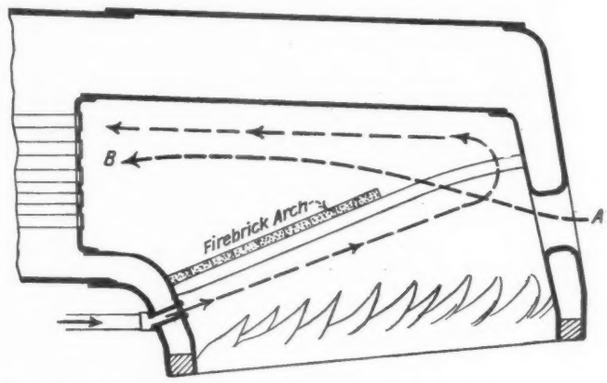


Fig. 2—The line A-B shows the course of the draft air from an opened firedoor. Suggested inlet where auxiliary preheated air is used

considered important enough to use active air heating in the tube zones of the boiler itself. Any waste heat saved would play but a minor role compared with the improved combustion efficiency and higher firing rates made possible in this way.

It is true that a considerable amount of air preheating would result in higher firebox temperatures that would seriously affect the safety of present type fireboxes. Watertube fire boxes with their better circulation and lack of crown sheet failures seem here again the natural solution.

Preheating the air supply is recognized as a necessity in the iron and steel industry. It may yet become a factor in solving the combustion efficiency problem on the locomotive and in making possible the successful forcing of the fires for power rates now unknown.

Powdered coal.—Powdered coal has been often suggested as one means of reducing the losses of combustion. One cubic inch of solid coal exposes only 6 square inches for burning, whereas a cubic inch of powdered coal exposes 20 to 25 sq. ft., so that theoretically at least thorough mixture with the required air and consequent rapid combustion should be a simple matter.

Practically, however, much difficulty has been encountered in burning it under boilers in the stationary field, where most of the pioneer work was done. Many failures resulted until it was found that it could be burnt with a fair degree of success where a sufficiently large furnace and combustion chamber were provided. The furnaces employed in most cases had a volume eight to ten times that of a locomotive firebox burning an equivalent amount of solid fuel, which put it beyond the pale of the locomotive field.

Stationary engineers are, however, now in the midst of experiments to devise means for more rapid com-

bustion of powdered coal in smaller furnaces, which are worthy of the attention of the railway world. Streamline combustion, in which the mixture of air and fuel took place slowly along a great length of stream, necessitating long combustion chambers and furnaces was the first successful method. It is now thought that ultimately opposing streams of air and powdered fuel may be employed to produce a vortex action, which will permit the use of a shorter flame and a smaller furnace. Should these attempts become successful their possibilities for locomotive use should not be overlooked.

It may then become practicable to install powdered coal injectors up near the smokebox end of a locomotive boiler, using a small stream of compressed air to blow the particles down a combustion chamber extending back to the firebox, which would be the real combustion chamber. Here a reversal of direction would occur and the flames sweep back through the tube areas, drawn by the exhaust suction.

Air tubes could be admitted from the smokebox end, carrying air forced through by the train velocity and preheated by the smokebox gases or other means to supply the auxiliary air required, placing the air jets at angles to the combustion stream to create the desired "vortex" action.

Such an arrangement may make possible the application of powdered coal burning to the locomotive as well as in the stationary field.

Fuel Association presents interesting report

Prevention of front-end air leaks and proper grate air openings important factors in fuel economy

NUMBERED among the many interesting reports presented at the eighteenth annual meeting of the International Railway Fuel Association, held at the Hotel Sherman, Chicago, May 11 to 14, was the report of the committee on front-end grates and ashpans. The report of the committee this year dealt with the prevention of front-end air leaks, the arrangement of ash pans, fireboxes and front ends of oil-burning locomotives, and the use of grates with restricted air openings.

In the section of the report dealing with oil-burning locomotives, the fact that cast steel fire pans are being employed to a considerable extent was recorded. It was also reported that the Atchison, Topeka & Santa Fe is eliminating arch tubes from its oil-burning locomotives, and by the use of a larger stack having an integral inside extension it has been possible to open up exhaust nozzles by ¼ in. in diameter.

Prevention of front-end air leaks

Most roads report what they seem to regard as adequate front-end inspection with respect to air leakage, but there is good reason to believe that the ordinary inspection methods do not disclose all the air leaks, and that in this matter there is room for almost universal improvement. The committee has not inquired widely about inspection methods, having confined its requests chiefly to devices for preventing air leaks. Our correspondence has, nevertheless, made it clear that most roads carry on systematic and regular front-end inspection. One fairly typical statement in this connection is as follows: "We are careful to candle the smokebox and make every attempt to prevent any air leaks; we are careful in making our front-end ring joint tight, using hollow asbestos tape; we are careful to have our stacks properly fitted to the stack base, and the base to the smokebox; all bolts and all rivets that enter the smokebox are made air tight and inspections are made at the end of each locomotive trip."

One of our correspondents says that in his contact with shop men he occasionally finds that they do not understand the real purpose of making the front-end tight against leakage—that some of them think it is for the purpose of preventing the outward leakage of smoke. If any such misapprehension is common it certainly indicates the need for better and more systematic instruction of those responsible for front-end inspection and maintenance.

As has been indicated, there is reason to doubt the effectiveness of the ordinary methods of inspection, and in support of this opinion one road—in no way behindhand in matters of inspection and maintenance sent three photographs two of which are reproduced in these pages. They show the results of leakage tests on locomotives "which had made their mileage as they came to the shop for general overhauling." In making the tests the tubes were closed by fitting wooden plugs into the flues and tubes at the back flue sheet, and the nozzle was blocked; the front-end was then filled with water by means of a hose inserted into the top of the stack. Beyond pointing out the fact that the leakage shown takes place under an average head of water equivalent to only about one and one-half pounds per square inch, the committee has no comment to make. The committee suggested that these simple tests be widely applied in order to check the effectiveness of inspection methods.

Leakage around steam pipes

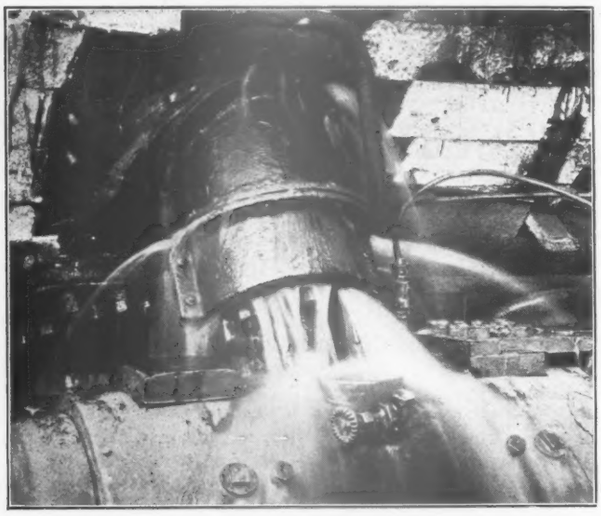
The various devices for the prevention of leaks around the steam pipes to which the committee's attention has been called are in the report. The committee's search was not exhaustive and there are doubtless other designs in use.

A ¼-in. cover plate is fitted close around the steam pipe and is electrically welded to the pipe and to the smoke-arch. In the Manual of the Mechanical Division of the American Railway Association, Section F, page 76, there is shown a very similar device in which, however, the cover plate is dished instead of being flat. The plate in this case is applied on the inside of the smoke-arch and is welded to the pipe and the arch.

In preventing leakage around steam pipes the Southern Pacific used a ⅜-in. plate bolted to the smokebox with 15 or 16 ¾ in. bolts. This plate is split for convenience in applying it and the split is subsequently welded. To this plate is welded a cylindrical casing made of ⅛-in. material; and a steel ring is fitted into the bottom of the

casing. This steel ring is cut in half before applying it to the steam pipe. After being applied it is welded together, then welded to the casing; and finally it is welded to the steam pipe and the weld caulked. The space between the outside of the steam pipe and the casing is one inch wide.

The Chicago, Indianapolis & Louisville surround the steam pipe with a cast iron sleeve which is bolted to the smokebox; the contact surface of the casting at the smokebox is finished. This sleeve is cast in two parts which are bolted together along two flange and finished joint faces. The bottom of the sleeve carries a flange and a stuffing box which is packed with asbestos rope. The jacket encircles the sleeve and extends to the smoke-arch.



Escaping water indicates more air leaks around steam pipe casing into the front end

Use of grates with restricted air openings

Last year the committee reported that in two railroads a radical departure had been made with respect to the total air opening through grates, which runs counter to the practice of securing the greatest possible air opening recommended by the committee. The A. T. & S. F., because of the waste due to fuel falling through the finger grates then in use, had changed to a table grate in which the individual air openings were greatly reduced. After the coal losses through the grate had been stopped, it was determined by means of gas analyses that more air than was required for proper combustion was being admitted, and the aggregate air opening through the table grates was reduced to as low as 16 per cent of the grate area. The committee also reported that the Northern Pacific, in trying to burn lignite coal, resorted to a similar practice, finally coming to a table grate with conical openings ½ in. in diameter at the upper grate surface, with the number of these holes such that the aggregate air opening was brought down to about 12 per cent.

This year, the report states, the committee in reply to letters, heard from 80 railroads on this subject, 55 of which have never deliberately restricted the grate opening, and 16 of which have reduced the size of the individual holes in the grates in order to reduce the loss of fine coal into the ash pan. In most instances, however, these roads have endeavored to keep the per cent of air opening as large as possible, generally from 35 to 45 per cent of the grate area.

Of the other nine replies, four only indicate clearly that material reductions in aggregate air opening have been made, reducing it to a total of from 14 to 19 per cent of the grate area. The St. Louis-San Francisco resorted to the practice in attempting to burn different grades of slack coals in locomotive service and obtain good results with table grates having 25/32-in. conical holes and an aggregate air opening of 19 per cent, with the draft slightly sharpened. The Chicago, Milwaukee & St. Paul, in order to burn lignite coal where this is available, has found that by the use of restricted grate openings a reduction of from 15 to 20 per cent fuel consumption is effected. The Oregon-Washington Railroad & Navigation Company already burning sub-bituminous coal on a table grate having about 43 per cent air opening, experimented with grates having air openings of 14 per cent, but failed to find any advantage in this grate. The Temiskaming & Northern Ontario developed grates in which the total air opening was reduced to about 16 per cent of the grate area on an engine equipped with an exhaust governor. The road reports, however, that the tests did not show any improvement in fuel consumption of this combination as compared with the fuel consumption of the locomotive before the exhaust governor was applied and the grate openings reduced.

Northern Pacific tests

The committee's report last year dealt at some length with the practice on the Northern Pacific where the grates with restricted air openings were developed as a part of the program to burn Rosebud coal, a Montana lignite carrying 25.66 per cent moisture and a heating value of 8,743 B.t.u. Since that time results of the tests of these grates have become available. These were represented by the committee in the accompanying table. The Red Lodge coal referred to in the table is a Montana bituminous coal bearing 11 per cent moisture and a heating value of 10,000 B.t.u. The Roslyn coal, a Washington bituminous, has about 4 per cent moisture and 12,000 B.t.u. The tests were made on a locomotive with 28-in. by 32-in. cylinders; a total weight of 320,000 lb., of which 240,500 lb. is on the drivers; 30,591 sq. ft. of evaporating heating surface; 838 sq. ft. of superheating surface, and a grate area of 70.3 sq. ft. It develops a tractive force of 57,100 lb. The grate for which the results are given in the first column of the table has a total air opening of 36 per cent of the grate area; that

Table showing evaporation of Rosebud, Red Lodge and Roslyn coals on three different grates—Northern Pacific

Kind of coal	Equivalent Evaporation, Pounds of Steam per pound of coal. On ¾ in. slotted grates	On ⅝ in. round hole grates	On ½ in. round hole grates
Rosebud	....	3.80	3.73
	....	3.95	3.82
	....	3.73	3.95
	....	3.93	4.00
	....	...	3.90
	....	...	3.74
Average evaporation	....	3.85	3.86
Relative evaporation	....	99.8	100.
Red Lodge	6.06	5.89	6.07
	6.14	5.69	5.78
	5.63	5.59	6.25
	5.70	5.85	6.07
	5.60	5.82	5.80
	5.71	5.92	6.07
Average evaporation	5.81	5.79	6.01
Relative evaporation	96.7	96.4	100.
Roslyn	6.51	6.61	6.01
	6.58	6.61	6.01
	6.34	6.64	6.39
	6.83	6.39	6.23
	6.69	6.77	...
	...	6.19	...
Average evaporation	6.59	6.54	6.28
Relative evaporation	104.8	104.1	100.

for which the results are shown in the third column has a total air opening of 13½ per cent of the grate area.

In connection with the Rosebud coal, attention is called to its low heating value and also to the fact that a high stack loss results from its lightness and friability. The table shows that the Red Lodge coal gives the best results with the grate having the smallest air opening, whereas with the Roslyn coal the best results are obtained with the larger air opening.

The committee quotes M. A. Dlay, general fuel supervisor, Northern Pacific, as follows: "I can sum up in a sentence what may be the keynote to the improvement that we experienced with all kinds of coal on the grate having restricted openings. It is simply that the results of the tearing effect and higher rate of combustion possible with larger volumes and velocity of air through larger grate openings are not obtainable through grates having smaller openings. In other words, there is less clinkering tendency through the ability to control the air flow through smaller individual openings than there is through the larger openings, and since the excess oxygen which is present in the stack gases is about the same with the restricted or unrestricted air openings, the air supply is presumably sufficient, and, being controlled, produces less clinkering."

In concluding, the committee made the following statement: "It is obvious from this record that the Northern Pacific in setting out to burn lignite coal, had to carry a thin fire bed, that it had to reduce the size of the individual holes in order to avoid disturbing this thin fire, and apparently with the draft prevailing in these engines it had to decrease the aggregate air opening through the grate in order to avoid an excess of air. The question arises whether this excess might not have been avoided by decreasing the draft; that is, whether after reducing the size of the individual holes the aggregate air opening through the grates might not have been kept in the neighborhood of 30 or 35 per cent, and the size of the nozzle increased."

The report was signed by Edward C. Schmidt (University of Illinois), chairman, J. S. Breyer (Southern), C. H. Holdredge (S. P.), V. L. Jones (N. Y. N. H. & H.), G. H. Likert (U. P.), John P. Neff (American Arch Company), J. L. Ryan (I.C.), C. B. Smith (B. & M.), G. A. Young (Purdue University) and F. Zeleny (C. B. & Q.).

Axle failures in cold weather

Are axle failures caused by crystallization? Are stresses increased by low temperatures?

By Norman Litchfield

IT seems to be the opinion of many mechanical department men that the number of axle failures in service is greater in cold weather than in warm weather. It is claimed that the larger number of failures is caused by a greater tendency of the metal to crystallize at low temperatures. As this is a question of considerable interest to motive power men, an attempt has been made in this article to assemble such data as is available in connection with the subject, which really resolves itself into four questions: First, is there a greater number of failures at low temperatures than at high? Second, are the failures caused by crystallization? Third, is steel inherently weaker at low atmospheric temperatures than at high? Fourth, are the stresses induced by a given load increased by low temperatures?

The first question may be answered, that the question is so often asked as to indicate that data is available to prove that an increase in axle failures during cold weather does occur, but we do not believe that any data proving this to be true has ever been published. There is always a matter of doubt in judging the accuracy of opinions held on such a subject. To arrive at a safe conclusion, carefully recorded data should be taken over a period of years, to show that an excessive number of failures has occurred with each recurrence of low temperatures. Supporting data is also necessary as to the nature of the break; whether it is a clean-cut snap, or whether it partakes of the nature of a gradual fracture. The latter is familiar to every one who uses steel subjected to constant shocks, vibrations and alternating stresses, such as occur in axles. The reason for laying down this condition is that when shafts of a given design and material fail after long continued rotation and are replaced with shafts of like design and material, it may be predicted with a fair degree of certainty that the new shafts will also fail, roughly speaking, after the same number of rotations, irrespective of temperature conditions, there being a sort of periodic life for a given shaft under a given stress. Both laboratory data and records from actual service confirm this statement. Considerable laboratory data is available, but comparatively little in the way of actual service records has been assembled. For such records, a good and continuing organization is required, coupled with a fair degree of patience, for the reason that the cycle may require a period of from eight to ten years, depending on the mileage made by the vehicle. Therefore, it must be proved that the occurrence of a large number of failures during cold weather has not happened to coincide with the end of the endurance cycle of a lot of shafts which were placed in service at about the same time. Furthermore, examination should be made to see whether the shafts were not about cracked through before they finally snapped in the cold spell. It is, of course, well known that a shaft will continue to run for a considerable time after it has cracked to such a point that only a surprisingly small section remains.

Closely allied with this subject is the question of how high is the normal working stress in the shaft. It is well known that the higher the working stress, the shorter will be the periodic life. This is substantiated by all the series of experiments which have been made both in this country and in Europe over the past 20 or 30 years. Service records show the same thing. One set of shafts of good design, but highly stressed, close to the elastic limit, has a quite definite periodic life,

whereas another set of the same general design and material, under a lower stress, shows an endurance life exceeding that of their resistance to wear at the bearings. It is, therefore, seen that all of the facts must be carefully analyzed before attempting to draw the conclusion that low temperatures are the cause of failures.

Assuming for the moment that this is the case, an analysis may be attempted of the possible reasons for such failures. In so doing, it may be simpler to consider the fourth question first; namely, are the stresses induced by a given load increased by low temperatures? This question almost answers itself in the affirmative, particularly in the case of car and locomotive axles. Faulty lubrication, a frozen road bed, sticky triple valves, frozen brake shoes, springs, etc., all tend to throw heavy and sudden strains on the axles, with consequent high stresses which may be accentuated and largely increased locally by poor design, such as sudden change in section, sharp fillets, keyways and other defects. Whether these increased stresses, which are difficult to determine, will be sufficient to bring about failure of an axle that would otherwise be safe, will depend largely on the intensity of the normal working stress in the shaft and its relation to the inherent resistant properties of the steel.

It being granted then that cold weather does tend to increase the stresses in shafts, there then arises the question as to whether the ultimate failure is caused by crystallization, by which is meant some change in the molecular structure of the steel, changing it from a granular substance to a crystalline one.

That some such change does take place is the opinion which is held by many in the practical field, but it is a theory which is thoroughly discredited by metallurgists. It is, however, not to be wondered at that many users of steel should hold to this opinion. A fracture in service often possesses a highly crystalline appearance, particularly in the case of a shaft which has cracked part of the way through over a period of time (a so-called gradual or progressive fracture) to the point where the remaining section is so small that it can no longer resist the strains imposed on it and the shaft suddenly snaps off. The user probably knows that the axle material when purchased new was tested in a tension machine and at that time showed a fine granular structure. If he cuts a piece from the broken axle as close as possible to the fracture and tests this specimen in the tension machine, he will probably find that it breaks with the original granular fracture, free from any sign of crystals. The natural inference is, therefore, that the steel had crystallized just at the point of failure and presumably nowhere else. But if he were to take and polish a specimen from the very fracture itself, etch it and examine it microscopically, he would find the original character of material, which proves quite clearly that no action has taken place, such as is expressed and implied by the word crystallization. The very same steel when new, had it been tested by first nicking slightly, holding in a vise, and then striking a sharp blow tending to bend it at the nicked section, would have broken or snapped off, showing a crystalline fracture. In other words, it may be positively stated that there is no such thing as crystallization of steel caused by long continued service. Whatever crystalline appearance there may be at the break comes only from the nature of the break, the inherent character of which is considerably different from that occurring in a tension machine, being more nearly akin to a nicked break.

Another term which has long been applied to such failures is "fatigue"—a term which apparently grew up from an impression that under long continued strain the very nature of quality of the steel changes or weakens in the same manner that a muscle weakens, so that it can no longer resist strain. This impression also is not borne out by laboratory and microscopic investigation. The word "fatigue" is still largely used by metallurgists, but it is tacitly agreed that the word is not to be taken as implying any sudden deterioration of the metal, but rather a gradual cleaving apart of the steel, particle by particle. This cleavage naturally starts with the fibres nearest the surface which are under the greatest strain, and as they break one by one the cleavage gradually progresses towards the center.

Altogether, the evidence is conclusive that shafts do not break by reason of any change in their crystalline structure. We may, therefore, pass on to the question whether any change occurs in the strength of the steel itself when subjected to low atmospheric temperatures. Existing data on this subject is somewhat meagre. While numerous experiments have been made on the behavior of steel under high temperatures, these experiments have been brought about by the wide use of steel in furnaces and mills which have to operate at high temperatures, and there has not been a similar widespread use of steel at correspondingly low temperatures to force many series of experiments under these conditions. In the last edition of J. B. Johnson's work on "Materials of Construction," it is stated "When steel specimens are exposed to temperatures below the freezing point of water, the static strength is higher and the ductility lower than at normal temperatures." As an example, he cites a test made at the U. S. Arsenal in Watertown in 1905, but it will be noted that this test was made by plunging the steel specimen in a bath of liquid air, the temperature of which was —220 deg. F., a temperature which, of course, is far below any atmospheric temperature even in the most rigorous climate. Hence, it has but little bearing on the behavior of steel at low atmospheric temperatures. As an indication, however, and merely as that, the results of the test may be quoted:

	At room temperature, + 76 deg. F.	At liquid air temperature, — 220 deg. F.
Ultimate tensile strength, lb. sq. in.	72,300	97,600
Elastic limit, lb. sq. in...	52,800	80,000
Elongation, per cent	29.3	10.7

The Engineering Record, July 21, 1906, in quoting the results of the above tests at the Watertown Arsenal, makes this statement: "The results of these experiments are similar to those that have been obtained by numerous other experimenters who have investigated the properties of steel under the same conditions, in that it is shown that a great increase is produced in the tensile strength of steel at low temperatures with a corresponding decrease in ductility." Unfortunately, for our purposes, it does not state who the "numerous experimenters" were. It may be pointed out that the decrease in ductility above observed does not necessarily mean that the material has become less able to resist shock and vibration. The evidence of these tests is not sufficient in itself to prove that steel is weakened by cold.

An early English reference to this subject is found in the Proceedings of the Institute of Civil Engineers, Vol. CXII, in which a description is given of some tests made in Austria in 1892 as a result of some breakages of gun carriages in that country. In these tests, specimens were subjected to two kinds of impact test, longitudinal and transverse, the test pieces being cooled in a solution of ice and salt at a temperature of 4 deg. F. They were plunged in this mixture after each blow. The uncooled specimens were tested at a mean temperature of 68 deg. F. The bars used for the transverse test were nicked with a file across the middle on the under side, and had dropped on them a weight of about eight pounds from a

height of six inches. It was found that the resistance to transverse impact was less at low than at normal temperatures; a smaller number of blows being required to produce rupture. The resistance to longitudinal impact was increased "to a remarkable extent by the reduction in temperature, while the elongation also became greater." It may be noted that this statement is somewhat at variance with the results of the Watertown Arsenal tests in liquid air, above quoted, wherein the static elongation was found to be decreased by the liquid air temperature. A summary of the Austrian tests follows:

	Longitudinal impact		Transverse impact		Tensile tests		Condition,
	No. of blows causing rupture	Elongation, per cent	No. of blows causing rupture	Deflection at middle, inches	Breaking stress, tons per sq. in.	Elongation, per cent	warm or cold
Gun carriage steel...	13.0	13.0	26.6	0.6	30.7	24.8	Warm
	26.6	36.4	9.4	0.17	30.09	26.7	Cold
Axle steel unhardened .	13.6	14.8	11.4	0.307	....	....	Warm
	30.3	24.1	5.2	0.165	....	....	Cold
Axle steel hardened	1.0	....	1.0	....	....	....	Warm
	1.0	....	1.0	....	....	....	Cold

It must be remembered, of course, that these tests were made well before the development of modern methods

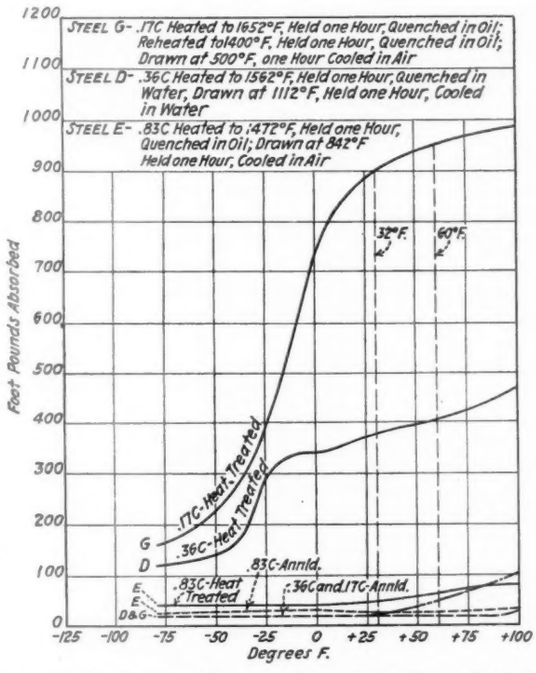


Chart showing the resistance to impact of three steel specimens at temperatures below 100 deg. F.

of heat treating steel, which probably accounts for the abrupt failure of the "hardened" axle steel.

An exceedingly interesting review of the history of the behavior of steel at various temperatures was given in a paper presented before the American Society for Testing Materials in 1924 by H. J. French and W. Tucker, entitled "Available data on the properties of irons and steels at various temperatures." The authors appended a bibliography of the subject, but it is found that, as usual, it refers mostly to the behavior of steel at high temperatures. However, one significant reference is made to a paper in the 1923 Year Book of the American Iron & Steel Institute describing an investigation of the influence of temperature on the Charpy impact value of a group of steels of varying composition, by F. C. Langenberg, metallurgist of the Watertown Arsenal, Watertown, Mass.

In the Charpy test a mounted pendulum is swung about a point and is capable of delivering a blow of about 217 ft. lb. The face of the pendulum is a hardened steel knife edge, rounded to a radius of about two millimeters. The test specimen is a small bar about 10 by 10 by 60 mm., and is notched to a depth of 5 mm. at the center. The pendulum strikes the specimen on the face opposite the notch and fractures it as a beam—chopping it in two, after which the pendulum ascends to an angle which depends on the energy remaining after the impact. Knowing the weight of the pendulum and the height of its center of gravity before impact, the energy of the blow can be determined. The height to which the center of gravity of the pendulum ascends after impact permits the determination of the energy remaining after impact. The difference between these two quantities is the energy absorbed by the test specimen and is the index of the resistance to impact of the specimen. While it is not contended that this test, by itself, gives a complete indication of the ability of a material to resist continued vibration and shock, yet it is in one way a very significant test, and one which, when taken into consideration with other tests and with microscopic examination of the grain structure, helps to obtain a good measure of the material. Mr. Langenberg gives results of his tests with three straight carbon steels, the first having a carbon content of 0.17 per cent; the second, 0.36 per cent, and the third, 0.83 per cent. All three steels were tested in the plain annealed state and also after heat treating. The heat treatment given to the soft .17 per cent carbon steel consisted of quenching in oil, and drawing and cooling in air. That given the mild .36 per cent carbon steel consisted of quenching in water, and drawing and cooling in water. The heat treatment of the hard .83 per cent carbon steel included quenching in oil, and drawing and cooling in air. Each heat treatment was calculated to give the best structure for developing the resistant powers of the material.

Mr. Langenberg states that in considering the heat treated condition "it may be remarked that the low carbon steel had received a treatment corresponding to that received by the core of a casehardened article; the medium carbon steel, a quench and a draw such as would be given when the material is used for structural parts. These steels were tested at temperatures from 80 deg. F. to high temperatures, which we are not concerned in this article. We have redrawn from the curve given in Mr. Langenberg's paper that portion which lies between 100 deg. F. and 32 deg. F., this being the range in which we are more particularly interested. This is shown in the chart. Mr. Langenberg states that "at a temperature of zero deg. F. and lower, there is practically no difference in resistance to impact when these steels are in the annealed condition." This is the only comment he has to make on the tests of the steels below the freezing point of water, his interest evidently being greater in the behavior of the steels at high temperatures. Luckily, however, he presents data sufficient to show the conditions at lower temperatures, and we have, therefore, replotted the curve to a scale which emphasizes the conditions below freezing. An xamination of thse curves shows three things quite clearly:—

First—The .83 per cent high carbon steel shows little or no difference in resistance to impact between the annealed and the heat treated conditions, its value being low in both and varying but little with change in temperature. To us, this is of more or less academic

interest only as this character of steel would not normally be used in railway equipment.

Second—The medium .36 per cent carbon steel is of a composition that makes it fall well within the axle class. Its tensile properties in the annealed state and when heat treated, were as follows:

	Yield point, lb. per sq. in.	Tensile strength, lb. per sq. in.	Elongation in 2 in., per cent	Reduction in area
Annealed	35,500	71,500	25.6	39.2
Heat treated.....	47,500	81,650	26.0	60.6

The 0.17 per cent carbon steel, which coincides with the .36 per cent curve until it passes + 25 deg. F. and then rises, although somewhat soft, may also be used by some for axles. In the annealed state, the resistance to impact of both the .17 per cent carbon steel and the .36 per cent steel are very low, but it is significant that the value stays nearly even between 60 deg. F. and 50 deg. F. Heat treating these steels apparently greatly increases their resistance to impact, being at 60 deg. F. some 20 times as great as in the annealed state. But with these steels in the heat treated condition, temperature changes have a marked effect. Calling the resistance 100 per cent at 60 deg. F., the relative values are:

Temp. deg. F.	0.17 per cent carbon	0.36 per cent carbon
+60	100	100
+32	94	95
0	76	85
—25	42	68
—50	24	35

It should be noted that even the reduced values of the heat treated materials at low temperatures are higher than any of the values, hot or cold, of the plain annealed materials. It would be interesting to ascertain whether future tests will bear out the figures given above and to have a study made of the causes of the change in value.

A special committee of the American Society for Testing Materials is studying the effects of temperature changes on the resistance of steel to impact and the hope is expressed that in considering the major subject of high temperatures, they will not overlook the lesser but important subject of low atmospheric temperatures. It would seem that the railroads might supply service data which would serve to amplify the committee's laboratory experiments.

In conclusion, we believe that it may be safely stated that cold weather does not cause crystallization, meaning thereby a permanent change in the crystalline structure. The same steels which showed a lessened resistance to impact at the low temperatures would undoubtedly regain their original properties when warmed again. It further appears that a proper heat treatment increases the resistance, but if in the design advantage has been taken of the increased tensile properties to reduce the diameter, thereby increasing the working stress, it is entirely possible that low temperatures may cause failure. These facts should, therefore, be taken into consideration in the design.

The available data is so meagre as to make it only possible in this article to point out the situation and express the hope that the subject may be carried further by those in a position to do so.

THE AVERAGE COST of coal used as fuel for road locomotives in freight and passenger train service and charged to operating expenses was $2.64 per ton in the first four months of this year, according to the Interstate Commerce Commission's monthly bulletin of railroad fuel statistics. This compares with $2.81 in the corresponding period of last year. The cost of fuel oil averaged 2.9 cents per gallon, as compared with 3.12 cents last year. The total cost of coal and fuel oil for the four months was $110,536,495, as compared with $112,693,960 last year. For April the average cost of coal was $2.65 and the average cost of oil was 2.92 cents.

Safety record at El Paso shops of the Southern Pacific

THE splendid record of the United States railroads in the conservation of life and in the reduction of injuries to employees, is well illustrated in the performance of the El Paso shops of the Texas and Louisiana lines of the Southern Pacific, which, according to a recent report from H. M. Mayo, superintendent of safety, have operated for over 27 months with but two injuries to the employees which classified as "reportable" according to the requirements of the Interstate Commerce Commission.

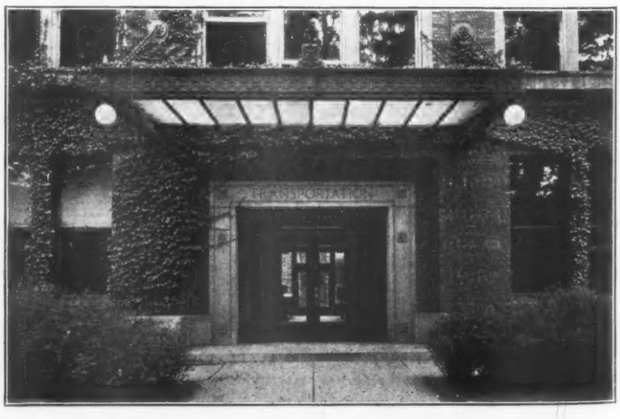
The El Paso shops employ an average of 650 men. In addition to roundhouse repairs, the plant is equipped for general and heavy repairs to locomotives and equipment and handles the heaviest type of power on the system, including Mountain and Pacific type locomotives in passenger service and 2-10-2 type operating both east and west of the Rio Grande.

During 1924 the plant worked 1,645,172 man hours, and during 1925 approximately the same. Adding the monthly average to include November and December of 1923, and January, 1926, brings the total man hours worked in the El Paso shops for 27 months of record to 2,734,701 hours against which is charged but two "reportable" injuries, or two injuries necessitating a loss of time of more than three days.

The management of the Texas and Louisiana lines of the Southern Pacific naturally feel pround of this fine record and give credit to the officers of the El Paso division and to the shop foremen and employees for the commendable results which have attended their efforts to create a safe shop.

Incidentally, the shops of the system located at Algiers, La., during 1924 reported one injury for each 357,721 hours worked, and for 1925 had decreased the number of injuries from seven in the previous year, to but three for 1925, working 747,753 man hours per injury. The rivalry between the two shops has been keen for several years. Prior to 1924 the Algiers shops had won the safety banner for three successive years. El Paso shops, however, won this much sought for award for 1924 and 1925.

The record of the five important shops of the Texas and Louisiana lines of the system for 1924 as compared with 1923 shows a reduction of 275 or 67 per cent. The reduction for 1925 compared with 1924 was 39 per cent, there being 131 reportable casualties in 1924 and but 80 in 1925.



Entrance to the Department of Railway Engineering, University of Illinois

Examples of recent locomotives of the 2-10-0, 2-10-2 and 2-10-4 types

Examples of recent locomotives of the 2-10-0, 2-10-2 and 2-10-4 types

Arranged in order of type and weight

Type	2-10-0	2-10-0	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-2	2-10-4
Railroad	Penn.	G. M. & N.	Penn.	B. & O.	Gt. Nor.	Can. Nat.	C.B. & Q.	C. R. I. & P.	A. T. & S. F.	So. Pac.	Wab.	A. C. L.	B. & M.	I. C.	U.S.R.A.	U. P.	U.S.R.A.	T. & P.
Road class or number	L-1-s	251	N. 1-s	S-1	Q 1	T-2-A	E-5-C	3,030	3,800	F-4	2,507	Q—1	3,006	3,025	Heavy	5,515	Light	600
Builder	Bald.	Bald.	A. & B.	B. & L.	Bald.	Can.	Bald.	Amer.	Bald.	Bald.	Amer.	Bald.	Amer.	Lima	A. & B.	A.B. & L.	A. & B.	Lima
Ordered or built	1922	1923	1918	1923	1923	1924	1922	1925	1924	1923	....	1925	1923	1922	1918	1924	1918	1925
Tractive force, engine, lb.	87,000	60,000	80,940	82,800	87,000	80,200	75,500	77,800	81,500	75,150	69,700	75,700	71,300	73,800	74,000	70,450	69,400	83,000
Tractive force, booster, lb.	.....	.....	.....	.....	.....	11,535	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13,000
Cylinder horsepower (Cole)	.....	2,421	3,325	3,568	3,630	3,030	3,000	3,244	3,406	3,136	2,954	3,163	2,878	3,082	3,082	3,136	2,624	3,787
Speed m.p.h. at 1,000 ft. piston speed	34.6	33.96	34.6	35.7	35.16	31.8	33.5	35.16	35.16	35.44	35.72	35.16	34.05	35.16	35.16	37.5	31.8	35.3
Weight of engine, lb.	371,800	251,100	435,400	434,500	422,340	309,240	405,710	405,000	400,490	398,000	395,000	391,980	357,000	381,000	380,000	365,623	352,000	448,000
Weight on drivers, lb.	342,050	225,500	351,300	344,500	342,490	321,780	312,510	317,500	316,760	306,000	314,000	303,060	299,000	296,500	293,000	288,877	274,000	300,000
Weight on front truck, lb.	29,750	26,600	23,100	32,000	24,720	28,780	32,740	27,000	30,840	31,500	28,500	27,120	25,000	28,500	28,500	28,423	23,000	41,800
Weight on trailing truck, lb.	.....	.....	61,000	58,000	55,130	58,680	60,460	60,500	52,890	60,500	52,500	61,800	33,000	56,000	58,500	48,323	54,000	106,200
Weight of tender, lb.	182,200	182,400	211,300	294,200	286,160	245,800	225,800	223,600	286,510	223,000	196,900	221,020	205,500	209,000	206,100	235,877	206,100	275,200
Wheel base, driving, ft. and in.	22—8	20—0	22—2	22—4	22—0	21—8	20—9	22—6	22—0	22—10	22—10	22—10	21—10	22—4	22—4	22—6	21—0	22—0
Wheel base, engine, ft. and in.	32—2	28—11	41—11½	42—11	42—7	42—2	40—1	42—7	41—1	42—4	42—4	42—9	39—7	42—2	42—2	41—5	40—4	46—8
Wheel base, engine and tender, ft. and in.	73—0½	65—1	82—7¼	89—10⅞	89—9⅝	80—9¾	79—5	82—8	85—2⅛	82—7½	78—4¼	83—0½	79—1	82—10	82—10½	79—6	75—11½	86—8
Cylinders, diameter and stroke, in.	30½x32	25x30	30x32	30x32	31x32	29x32	30x32	30x32	30x32	29½x32	29x32	30x32	29x32	30x32	30x32	29½x30	27x32	29x32
Driving wheels, diameter, in.	62	57	62	64	63	57	60	63	63	63½	64	63	61	63	63	63	57	63
Steam pressure, lb.	250	215	205	220	210	200	185	200	210	200	195	195	190	190	190	200	200	250
Fuel	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal	Bit. coal	Oil	Oil	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. coal	Oil
Boiler, diameter, first ring, in.	84½	76	88¾	90	90	84½	96	84	88	90	86	88	84½	88	88	86¼	86	86½
Firebox, length, in.	125½	108⅜	144	132⅜	132	120	131⅞	120⅜	132⅞	132	120⅜	132⅜	150⅜	132⅜	132⅜	126	114⅜	150¼
Firebox, width, in.	79⅞	86¼	80	96	96	96¼	96	96¼	96	90	96¼	96¼	96¼	96¼	96¼	96	96¼	96¼
Tubes, number and diameter, in.	114—2¼	217—2	196—2¼	232—2¼	270—2⅛	264—2¼	264—2¼	210—2¼	255—2¼	261—2¼	253—2¼	256—2¼	320—2	271—2¼	271—2¼	260—2¼	247—2¼	82—2¼
Flues, number and diameter, in.	200—3¼	36—5¾	54—5½	53—5½	60—5½	60—5½	45—5½	50—5½	54—5½	50—5½	48—5½	50—5½	50—5¾	50—5½	50—5½	45—5½	45—5½	184—3½
Length over tube sheets, ft. and in.	19—1	17—6	20—10¾	23—0	21—0	21—6	22—7½	23—1	20—9	21—0	23—0	20—6	19—0	20—6	26—6	22—0	20—6	21—6
Grate area, sq. ft.	69.6	64.7	80	88	88	80.3	88	80.3	88.3	82.5	80.2	88.2	80.3	88.2	83.2	84	76.3	100
Coal rate, lb. per sq. ft. grate per hr. (Cole)	....	122	135	132	134	122.5	111	131.5	125	123.5	120	117	116.5	113.5	113.5	121.5	111.8	123
Steam required per hour, lb. (Cole)	....	50,400	69,200	74,200	75,500	63,000	62,400	67,500	70,800	65,200	61,450	65,800	59,900	64,200	64,200	65,200	54,600	78,700
Heating surface, firebox, total, sq. ft.	312	229	423	375	477	356	381	445	417	381	379	426	303	432	429	341	373	473
Heating surface, tubes and flues, sq. ft.	4,506	2,862	4,302	4,876	5,134	5,178	4,966	4,495	4,711	4,722	4,991	4,549	4,498	4,728	4,727	4,774	4,293	4,640
Heating surface, total evap., sq. ft.	4,818	3,091	4,725	5,251	5,611	5,534	5,347	4,940	5,128	5,103	5,370	4,975	4,801	5,160	5,156	5,115	4,666	5,113
Superheating surface, sq. ft.	1,986	693	1,618	1,512	1,518	1,558	1,246	1,424	1,405	1,329	1,129	1,230	1,167	1,285	1,230	1,252	1,085	2,100
Comb. evap. and super. surface, sq. ft.	6,804	3,784	6,343	6,763	7,129	7,092	6,593	6,364	6,533	6,432	6,499	6,205	5,968	6,445	6,386	6,367	5,751	7,213
Tender, water capacity, gal.	9,000	8,500	10,000	15,800	15,000	13,200	12,000	12,000	15,000	12,000	10,000	12,000	12,000	12,000	12,000	12,000	10,000	14,000
Tender, fuel capacity, tons or gal.	17½	18	20	23	5,000	16	22	18	5,000	4,000	18	16	16	16	16	5,200	16	5,000
Weight on drivers ÷ weight eng. per cent.	92.1	89.9	80.7	79.2	81.1	78.5	77.1	78.4	79.1	76.9	77.0	77.3	83.7	77.7	77.1	79.0	77.8	67.0
Weight of drivers ÷ tractive force.	3.93	3.76	4.34	4.16	3.94	4.01	4.14	4.08	3.89	4.07	4.51	4.00	4.19	4.02	3.96	4.10	3.95	3.62
Weight of engine ÷ cylinder horsepower.	....	103.7	130.9	121.8	116.3	135.0	135.2	124.8	117.6	126.9	133.7	123.9	124.0	123.6	123.2	116.9	134.1	118.3
Weight of engine ÷ combined h.s.	54.6	66.3	68.6	64.2	59.2	57.7	61.5	63.6	61.3	61.9	60.8	63.2	59.8	59.1	59.5	57.4	61.2	62.1
Comb. heat. surface ÷ cylinder horsepower.	....	1.56	1.88	1.89	1.96	2.34	2.20	1.96	1.92	2.05	2.20	1.96	2.07	2.09	2.07	2.03	2.19	1.90
Tractive force ÷ comb. heating surface.	12.78	15.85	12.76	12.24	12.20	11.32	11.45	12.23	12.47	11.68	10.73	12.19	11.94	11.45	11.58	11.06	12.07	11.5
Tractive force × diam. drivers ÷ comb. h. s.	793	904	791	782	769	644	687	771	785	742	686	768	728	721	730	697	687	725
Cylinder horsepower ÷ grate area	....	37.42	41.56	40.55	41.26	37.65	34.08	40.40	38.55	38.01	36.83	35.88	35.84	34.94	34.94	37.32	34.40	37.87
Comb. heat. surface ÷ grate area	97.8	58.5	79.3	76.9	81.0	88.3	74.9	79.2	74.0	78.0	81.1	70.4	74.4	73.1	72.4	75.8	75.4	72.1
Firebox heating surface ÷ grate area	4.48	3.54	5.29	3.52	5.42	4.43	4.33	55.4	47.3	46.2	47.2	48.3	3.77	49.0	4.87	4.06	4.90	4.73
Firebox heat. surface per cent evap. h. s.	6.48	7.41	7.96	4.73	8.50	6.43	7.12	9.01	8.13	7.47	7.06	8.56	6.31	8.38	8.32	6.67	7.99	9.26
Superheating surface per cent evap. h. s.	41.2	22.4	34.2	22.3	27.1	28.1	23.3	28.8	27.4	26.0	21.0	24.7	24.3	24.9	23.8	2.45	23.3	47.1
Notes	b-e-f-k	b	a	b	b	a-g	b-e	a-d	b-e	b-e	a	b	a	b	b	a	b	b-d-e-g-k

Key to notes: a—Boiler diam., inside; b—Boiler diam., outside; d-Syphon; e—Feedwater heater; f—Limited cut-off; g—Booster; k—Type E superheater.

A Consolidation Type locomotive built in the Canadian National Shops at Winnipeg, Man.

C. N. builds 2-8-0 locomotives from surplus material

THE Canadian National has just completed at its Transcona shops, near Winnipeg, Man., two Consolidation type locomotives which are the first locomotives built by this road in their own shops and which are also the first locomotives built in western Canada. There are sixty of this type on the western region which were built in 1911 and 1912, and which have proved to be the most satisfactory class of power of their size in service on this territory.

They are of rugged construction with satisfactory boiler capacity and with wide fireboxes. These locomotives have proved to be very economical as regards maintenance both of the boilers and the machinery.

This class of locomotives may be used for either freight or passenger service as they have enough speed to handle ordinary passenger trains in this territory when required. In territory where traffic is not too heavy they are used for main line time and drag freight trains, as in this region, where the main line grades do not exceed .4 per cent, the regular rating for this class of power is 2,730 equated tons.

Because of the rugged construction of these locomotives they have been found to require a minimum of repairs. As a result it was decided to build the two new locomotives partly to make use of spare parts which were in stock and which were found to be surplus. The new locomotives therefore, are in the main, reproductions of these consolidation locomotives built in 1911 and 1912, but many economy devices have been added to make them modern. The 8½-in. cross-compound air compressor has been applied on the right side to provide ample space for the application on the left side of the constant flow pump of the Elesco feedwater heater.

One pair of frames was supplied from the Canadian Steel Foundries, Montreal, and one pair of cylinders from the Point St. Charles shops of the Canadian National, Montreal. Similar parts for the first engine was surplus material on hand in stock at Transcona. With the exception of these parts and the engine deck casting, all steel castings for the new engines were furnished by the Vulcan Foundry, Winnipeg, and all brass castings by the North Western Brass Company, Winnipeg.

The grey iron castings were made in the Canadian National Foundry at Transcona and all forgings including the main and side rods, motion parts, axles, etc., were made in the Transcona shops.

Table of dimensions, weights and proportions

Railroad	Canadian National
Type of locomotive	Consolidation
Service	Freight
Cylinders, diameter and stroke	21½ in. by 30 in.
Valve gear, type	Walschaert
Valves, piston type, size	14 in.
Maximum travel	6 in.
Outside lap	1 in.
Exhaust clearance	Line and line
Lead in full gear	1/8 in.
Weights in working order:	
On drivers	187,300 lb.
On front truck	27,000 lb.
On trailing truck	None
Total engine	214,300 lb.
Tender	172,100 lb.
Wheel bases:	
Driving	17 ft.
Rigid	17 ft.
Total engine	25 ft. 9in.
Total engine and tender	59 ft. 2 in.
Wheels, diameter outside tires:	
Driving	63 in.
Front truck	34¼ in.
Trailing truck	None
Journals, diameter and length:	
Driving, main	9½ in. by 12 in.
Driving, others	9 in. by 12 in.
Front truck	6½ in. by 12 in.
Trailing truck	None.
Boiler:	
Type	Extended wagon top
Steam pressure	205 lb.
Fuel, kind	Bituminous
Diameter, outside first ring	66⅜ in.
Firebox, length and width	96⅞ in. by 75¼ in.
Tubes, number and diameter	166—2 in.
Flues, number and diameter	26—5¾ in.
Length over tube sheets	14 ft. 1⅜ in.
Grate area	50.62 sq. ft.
Heating surfaces:	
Firebox and arch tubes	231.4 sq. ft.
Tubes and flues	1,741.54 sq. ft.
Total evaporative	1,972.94 sq. ft.
Superheating	465 sq. ft.
Comb. evaporative and superheating	2,437.94 sq. ft.
Tender:	
Style	Rectangular
Water capacity	7,500 gal.
Fuel capacity	12 tons
General data estimated:	
Rated tractive force, 85 per cent	38,000 lb.
Cylinder horsepower (Cole)	1,581
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	88.7
Weight on drivers ÷ tractive force	4.93
Total weight engine ÷ cylinder hp	133.3
Total weight engine ÷ comb. heat. surface	86.9
Boiler proportions:	
Comb. heat surface ÷ cylinder hp	1.54
Tractive force ÷ comb. heat. surface	15.6
Tractive force × dia. drivers ÷ comb. heat. surface	985
Cylinder hp. ÷ grate area	31.25
Firebox heat. surface ÷ grate area	4.56
Firebox heat. surface, per cent of evap. heat. surface	11.71
Superheat. surface, per cent of evap. heat. surface	23.59

These locomotives are equipped with Franklin, No. 8 butterfly firedoors and automatic driving box wedges, Pyle National headlight equipment, Detroit five-feed hydrostatic lubricator, King metallic packing, Franklin radial buffer, Barco joints, Huron arch tube and washout plugs and with the Westinghouse E. T. air brake equipment.

After the various parts were fabricated, the frames for engine No. 2747 were laid down on March 11 and the locomotive was completed by April 19, a total of 27 working days being required to erect and complete the engine. This additional work was over and above the ordinary shop output on repairs to other locomotives which was not interfered with in any way.

The frames for the second engine, No. 2748, were laid down on April 15 and the locomotive was completed on May 19.

After the trial trips were made, these engines were used on main line time freight trains in the Alberta district where the best use can be made of this type of locomotive and where the fuel saving devices with which they are equipped will be able to give the most economical results.

Drafting locomotives to secure increased efficiency*

YOUR committee thinks that the problem is: How are we going to regulate air openings into the ash-pan through the grates and fire-bed to admit the proper amount of air? Let us see what is being done by some of the roads. One of the large roads has installed a table grate with 18 per cent air openings, which they claim is giving ample air for good combustion and materially reduces fuel losses through the grates when firing up in terminals and in service on the line. In connection with this, they are using on all their large power double ported nozzles, which have separate cavities for the exhaust of each cylinder; the exhaust from one side comes through the dumbbell-shaped opening in the nozzle stand, while the exhaust from the other sides comes out of the two holes on each side of the dumbbell opening. Indicator cards taken show a reduction of back pressure by the use of this type of nozzle as compared to the standard one formerly used.

Other companies are adopting grates with as high as 55 per cent air openings and claim by doing so they are able to increase the size of nozzle tips and get a better draft, save fuel and make much longer runs without cleaning fires.

The size and length of the stack is often mentioned in connection with the draft of a locomotive. At the present time, however, the length of the stack is governed largely by the height of the overhead bridges, tunnels, etc.; therefore this feature cannot be considered, and it is the opinion of your committee that by increasing the diameter of the smoke-stack good results will be obtained. Tests made on a large passenger engine with a 20-in. stack at a speed of 60 miles an hour with 200 lb. steam pressure showed a 4-in. vacuum in the smoke-box. This same engine had the stack changed to one of 25-in. diameter, and, under the same conditions, showed a vacuum of 4.5-in., indicating that the velocity of the exhaust had been retarded by coming in contact with the inner surface of the smaller stack and that the entrainment of the gases had been facilitated by the use of the larger stack.

It has been stated at previous conventions that the petticoat or lift pipe is more economical on fuel than the extension stack. As both serve the same purpose, that is, to line the exhaust steam with the stack and carry the gases out of the smoke-box, we can see nothing in favor of the former over the latter in the way of saving fuel, but there is this in favor of the extension stack that there is not the trouble with its coming loose and causing steam failures, and if it is adjusted correctly and of the proper size we believe that its use is an advantage over that of the petticoat or lift pipe.

As to the proper amount of air openings with oil burning locomotives, it is understood that this depends on the size of the locomotive (that is, the fire-box area), and is determined in different ways. Sometimes it is figured according to the area of flue openings, making the air intake to the fire-pan equal to 40 per cent or 45 per cent of flue openings; and in other ways by the area by volume of cylinders, the figure .027 times the volume of one cylinder being used; as an illustration, for a 25-in. by 28-in. cylinder Pacific type passenger engine this amounts to 370 sq. in. It has been found, however, that engines equipped with this amount of air openings in the fire-pan make considerable gas and smoke if an excess of oil is used by the slightest opening of the firing valve. In order to avoid this and produce better combustion the air openings are increased by cutting an opening on each side of the fire-pan 5-in. wide and 10-in. long near the bottom of the fire-pan, just forward of the regular air opening in the rear of the pan. This makes an addition of about 100 sq. in. added to the rule for proper air openings on the size of engines referred to. By using this addition of air openings on larger engines in proportion to what they formerly had, as figured by this rule, it not only increases the steaming qualities of the engine, but decreases the fuel consumption. Still another formula is to take the volume of one cylinder (that is, its diameter multiplied by the stroke), then use 2.7 per cent of the total for the air openings in the fire-pan, dividing this in the proportion of 15 per cent around the burner and 85 per cent in bottom of the rear end of the fire-pan.

The air openings around the burner vary in size; however we find openings of 6 in. by 8 in. and 6 in. by 10 in. give very satisfactory results, and the burner should fit in the middle of the opening, so that the bottom of the burner will be about 4 in. above the floor of the fire-pan and lined so it will be perfectly straight and the oil will not strike either the floor or sides of the fire-pan.

In conclusion, it is just as important that the proper amount of air be admitted in the right way to an oil-burning locomotive as it is to coal-burning locomotive. Draft means a current of air, and as air is the only thing connected with the operation of a locomotive that costs nothing and is the blood stream and life-giving element of combustion, your committee firmly believes the judicious use and control of it is essential and of the most importance in drafting locomotives to increase their efficiency and economy in coal and oil fields.

The report was signed by J. D. Heyburn, chairman, master mechanic, St. L.-S. F.; J. C. Simino, traveling engineer, S. P.; E. R. Boa, road foreman of engines, N. Y. C.; G. W. Coyle, mechanical examiner, B. & O.; and D. Meadows, assistant division master mechanic, M. C.

Discussion

James Fahey, Nashville, Chattanooga & St. Louis, took issue with the committee on the question of down draft when the exhaust does not fill the stack, stating that a ball of waste or flag would be drawn into and down the stack under such conditions. David Meadows, Michigan Central, called attention to the vital importance of lining the nozzle and stack so that the steam will not impinge more on one side than on the other. He recommended chang-

*Abstract of report presented at the thirty-third annual convention of the Traveling Engineer's Association, Chicago, September 15-18, 1925.

ing the stack size to suit the nozzle rather than changing the nozzle to suit the stack. The good results secured with the basket bridge were explained by two representatives from the New York Central who said that, while breaking the exhaust to fill the stack, this type of bridge does not increase the back pressure in the cylinders. Another member related his experience on a road having a class of freight power which was not giving satisfactory service due to excessive back pressure. The first change made was to increase the size of the nozzle, when it developed that the locomotive would not make steam. The stack was then enlarged, with no improvement in steaming ability. The taper of the nozzle was then changed to make the steam jet fill the stack and this proved to be the solution of the difficulty.

It was brought out that the rules laid down for front end design by the Master Mechanics' Association in 1904 are now obsolete and a complete reconsideration of the various factors entering into nozzle, stack and entire front end design must be given. The impossibility of changing one element of the design without affecting the others was also emphasized. One of the members said that it was a mistake always to go to the nozzle when trouble is experienced with excessive back pressure. The setting of the valves also has an effect and the trouble may be, for example, lack of exhaust clearance.

There was considerable discussion between the advocates of large and small air openings in the grates, as affecting the efficiency of locomotive draft. One group maintained that the larger the openings, up to 45 or 50 per cent, the better the results, whereas others testified that table grates with air openings as small as 12 per cent are securing good results with certain lignite coals which burn with a fine ash, much of which passes out the stack. The advantages claimed for the table grates are the prevention of loss in firing up and the prevention of a considerable amount of stack loss when locomotives are working hard with a relatively light grade of coal in the firebox. C. C. Shaw, International-Great Northern, said that the whole question of providing draft for locomotives, particularly as relates to the grate design, is to keep the air openings through the grates adequate after the locomotive has been in operation for a considerable period of time.

Safety Section, A. R. A. reports progress

THE Safety Section of Division I, American Railway Association held its ninth annual meeting at the Hotel Statler, St. Louis, Mo., April 27, 28 and 29, 1926. During this meeting a report was made by the Committee on Statistics, of which Thomas H. Carrow, supervisor of safety, Insurance Department, Pennsylvania, is the chairman, which included a number of vital statistics which directly concern the mechanical department. Following is an abstract of the report.

Progress and possibilities in safety

The progress in accident prevention is clearly written in the yearly records of the Interstate Commerce Commission. These records can be traced in such detail as to enable us not only to put our finger on the improvement that has been effected, but more particularly to point out the additional specific action that must yet be taken to establish maximum safety.

Causes and remedies

Great emphasis must be placed upon the proposition that the solution of the accident problem consists of first, ascertaining not only the general but the specific conditions that have, and if permitted to exist, will continue to cause accidents and, second, applying not general but specific remedies.

In the following table various dates are shown because of changes or lack of uniformity in the classifications, and "All Persons" includes all other classes of persons not specified.

Railway Accidents

(I. C. C. Reports)

	Employees		Passengers		Trespassers		All persons	
Year	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured
1913	3,715	171,417	350	15,130	5,558	6,310	10,964	200,308
1925	1,600	119,000	175	5,624	2,644	2,928	6,766	137,435
Decrease ...	2,115	52,417	175	9,506	2,914	3,382	4,198	62,873
Per cent...	57	31	50	63	52	54	38	31

In the year 1913 10,964 persons of all classes were killed in railroad accidents of all kinds and 200,308 were injured. These figures constitute the greatest number of casualties that ever occurred in any year, and 1925 compared with 1913 shows a reduction of 32 per cent. By a singular coincidence this percentage of reduction is almost exactly the same as called for by our safety goal of 35 per cent. Employees show a reduction of 57 per cent in killed and 31 per cent in injured; passengers a 50 per cent reduction in killed and 63 per cent in injured and trespassers a 52 per cent reduction in killed and 54 per cent in injured.

These reductions are made more impressive by associating the figures with the tons carried in 1913, which amounted to 2,058,000,000 tons compared with 2,260,000,000 tons in 1924, the latest available figures. A corresponding increase has been shown in the passenger business of the railroads.

A resolution—Maintenance of Equipment department

The report concluded with sets of resolutions, one for each department. That for the mechanical department follows:

Whereas, there are 540,000 employees in the Maintenance of Equipment department of the railroads of the United States, of whom 221 were killed and 53,311 were injured in 1924, representing 15 per cent of all fatalities and 43 per cent of all injuries to employees on duty, and

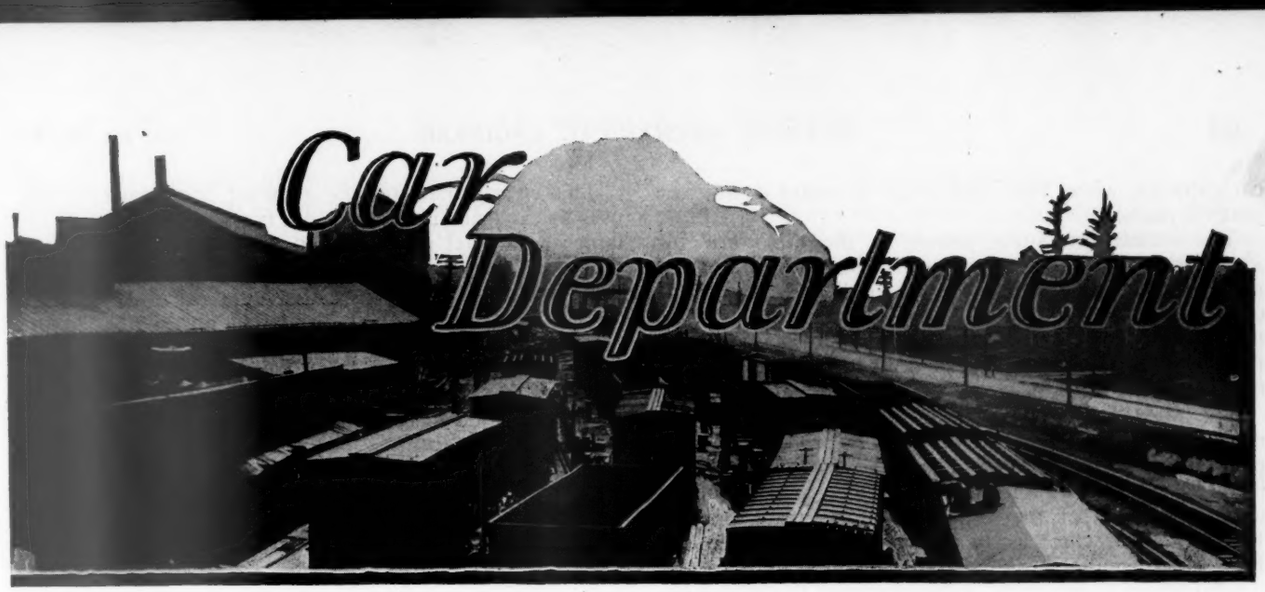
Whereas, the general causes of accidents and percentage of accidents due to each general cause are as follows: Physical conditions (defective material and equipment, lack of safeguards, litter or other physical hazards) 5 per cent; human factor (violation of rules and other forms of negligence, 10 per cent, and carelessness, thoughtlessness, indifference, ignorance or physical and mental unfitness and misadventure, 85 per cent); and

Whereas, the means of preventing accidents are as follows: Physical conditions (improved design and construction, better maintenance and installation of necessary safeguards); human factor (improved training, supervision and discipline, and safety organization, education, persuasion, co-operation and first aid and medical attention); and

Whereas, injuries due to poor housekeeping, poor illumination, slipping and falling, handling material, handling and use of hand tools, particles in the eye, burns, etc., constitute the majority of the injuries to maintenance of equipment employees, which renders proper selection, safety supervision and training imperative, and

Whereas, master mechanics are responsible for the introduction of appropriate safety measures in the maintenance of equipment department,

Resolved, That the Safety Section, American Railway Association, appeals to all master mechanics and other officers in charge of maintenance of equipment to provide, through their general foremen, foremen, assistant foremen, gang leaders and other supervisory forces, full and complete safety supervision and training of maintenance of equipment employees, particularly new and inexperienced men, to the end that maximum safety may be assured and a 35 *per cent reduction in casualties by* 1930, which is the safety goal of the railroads, may be achieved.



Increased iron wheel flange thickness proposed

Greater safety, longer service and reduced maintenance cost will result from reinforcement

By F. K. Vial,
Vice-President and chief engineer, Griffen Wheel Company, Chicago

As long ago as 1912 and 1913 the American Railway Association Wheel committee called attention to the desirability of reinforcing the flange of chilled iron car wheels. Several million chilled iron wheels are in service with their flanges thicker than the A. R. A. maximum and with no standard gages for their acceptance or mounting. This condition is clearly recognized by the Wheel committee in its report of 1923, page 12, which states:

"It is understood that wheels having different tread contours and flange sizes greater than those shown in standard drawings will not be included under the class of improper repair wheels. The committee's reason for excluding the tread contour and the flange dimensions is that this subject is still open for discussion by the committee and a number of roads are using special tapers and also a special reinforced flange, which in no way affect the safety of the wheel."

Also in its recent report at Atlantic City the following reference is made:

"The standard A. R. A. gage for mounting cast iron wheels has been subjected to much criticism because of the difficulty in using it in mounting two maximum flanged wheels, or wheels where the tread wear results in a maximum flange. Difficulty is also experienced because of the inadaptability of the gage for use on reinforced wheels which are being used by a number of railroads."

The time is now opportune for reconciling the A. R. A. gages to a desired flange design which can be made standard. All the preliminary work of preparing the way for an improved standard has been accomplished. It has been shown that it is entirely possible to increase the factor of safety of worn flanges 30 per cent to 50 per cent. The American Railway Engineering Association has given its approval to the feasibility of an increased thickness of flange from a track standpoint. It is, therefore, pertinent at this time to develop the whole subject, showing the flange requirements, the present status of the relation of flange to track, the laboratory tests showing the increased strength of flange, and the service records indicating a decided improvement in the factor of safety.

Flange requirements

The chilled iron wheel was designed and introduced into the railway service of the United States when wheel loads were comparatively small. As wheel loads increased from 5,000 lb. to 30,000 lb., the plate, hub, bracket and tread sections were increased sufficiently to take care of the increased service requirements. The reliability of the flange has been sueh that practically no change in thickness has been made from the time of its first introduction. There is sufficient evidence, however, to demonstrate that the flange is no exception to the well established law of engineering design that to obtain a uniform factor of safety the metal must be proportioned to the stress. Table I indicates the growth in

Table I—Comparison of the growth in car capacity, wheel load and flange pressure during 50 years

Capacity of axle	Journal size, inches	Year axle recommended	Car capacity, lb.	Load on wheel, lb.	Normal flange pressure on curves, lb.
.....	.....	....	20,000	5,000	3,750
15,000	3¾ by 7	1873	40,000	8,250	6,200
22,000	4¼ by 8	1889	60,000	12,000	9,000
31,000	5 by 9	1896	80,000	16,500	12,375
38,000	5½ by 10	1899	100,000	20,125	15,100
50,000	6 by 11	1910	140,000	26,250	19,700
60,000	6½ by 12	1918	170,000	31,000	23,250
70,000	7 by 13	1920	200,000	35,000	26,250

car capacity, wheel load, and flange pressure during the past 50 years.

The normal pressures shown in the table are for ideal conditions. The pressures may be doubled momentarily on irregular track, which at high speed cause the car to sway back and forth, delivering impact blows of large magnitude. It is, therefore, necessary in considering a factor of safety to add a liberal amount to the figures shown for impact.

The advent of the 100,000-lb. capacity car caused the manufacturers of chilled iron wheels to proportion every part of the wheel design to meet the service required of it. The question of reinforcing the flange was brought to the attention of the Wheel committee in the years 1909 and 1910, which led to a survey by them in the year 1915 to determine the number of broken flanges in the United States in one year. Conclusions of this investigation were reported at the 1916 convention at Atlantic City, as follows:

"Failures of flanges of cast iron wheels under fair usage, other than those caused by circumferential seams, are so rare as to be almost unknown."

A railway magazine referring to the Committee's report, commented as follows:

"Rightly viewed, this committee's report is the highest possible encomium upon the chilled iron wheel."

The comments, based on the study of all the broken flanges reported in one year, are listed in Table II.

Table II—Number of broken flanges reported in one year

Weight of wheel, lb.	Year cast	Thickness of flanges at a point 1/8 in. above tread: Less than 1/8 in.	1/8 in. to 1 in.	Over 1 in. to 1-1/16 in.	Over 1-1/16 in. to 1-1/8 in.	Over 1-1/8 in. to 1-3/16 in.	Over 1-3/16 in. to 1-1/4 in.	Over 1-1/4 in.	Totals
625	1915	..	..	..	..	..	..	..	..
	1914	1	..	..	..	..	..	..	1
	1913	..	..	..	..	..	..	1	1
	1912	1	..	..	2	..	2	..	5
	1911	..	..	..	..	..	..	1	1
	1910	..	..	..	1	..	..	1	2
	1909	..	1	..	..	..	..	..	1
	Total	2	1	..	3	..	2	3	11
675	1915	..	..	..	..	..	..	..	..
	1914	..	..	..	..	..	1	..	1
	1913	..	2	1	1	..	2	..	6
	1912	..	..	1	1	2	2	..	6
	1911	..	..	1	..	..	..	..	1
	1910	..	2	..	..	..	..	..	2
	1909	..	..	3	..	..	..	..	3
	Total	..	4	6	2	2	5	..	19
725	1915	..	..	..	..	..	..	..	..
	1914	..	..	2	1	2	..	2	7
	1913	..	2	2	5	6	2	2	19
	1912	.	1	11	5	3	5	..	25
	1911	..	1	4	..	1	2	..	8
	1910	..	..	6	1	3	2	2	14
	Total	..	4	25	12	15	11	6	73

This table is extremely instructive in showing the relative strength of new and worn flanges, and also the relationship of gross load to broken flanges. Inasmuch as flange pressure bears a direct ratio to load, we would expect an increase in the number of broken flanges as car capacities increase. This is shown by the fact that there were 11 broken flanges under 30-ton cars, 19 under 40-ton cars and 73 under 50-ton cars. The relative number of cars in service of the various capacities at the time the investigation was as follows:

Car capacity	Wheel weight	Percentage of total cars in the United States	No. of broken flanges	Percentage of flange failures reported
30-ton	625 lb.	44 per cent	11	10.7 per cent
40-ton	675 lb.	29 per cent	19	18.4 per cent
50-ton	725 lb.	27 per cent	73	70.9 per cent

This clearly indicates the growing percentage of failures as car loads increase, and a further inspection of the table shows that in the 50-ton class the great preponderance of breakages occurred when the flanges were worn thin, and the practical freedom of breakage in new flanges. There were 50 broken flanges under 50-ton cars when the flange had worn to within 3/16-in. of the condemning limit. All these flanges passed the initial stages of wear without breakage. Hence, the final 3/16-in. worn from a flange is a large element in the factor of safety, and if 3/16-in. is placed on the back of the flange the full factor of safety is retained even when worn to the present condemning limit.

Table II represents 103 broken flanges in one year's service of 20,000,000 wheels running 10,000 miles, mak-

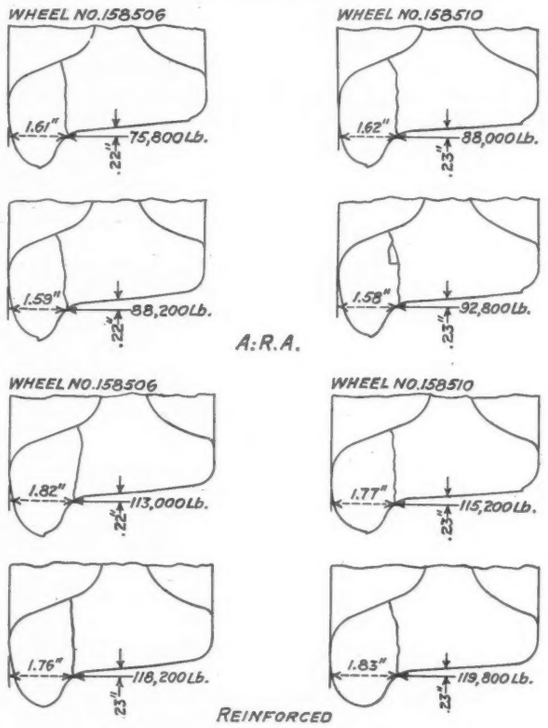


Fig. 1—Strength of new flanges with force applied 1/4 in. below tread line—The A. R. A. flange was cast on one-half of the 725-lb. wheels; a reinforced flange 3/16-in. thicker was cast on the other half of the same wheels

ing a grand total of 200,000,000,000 wheel miles, or one broken flange for each 2,000,000,000 wheel miles, or for one wheel running 200,000 years.

While this record may be considered satisfactory as compared with breakages in other parts of the car, the wheel manufacturers for the past fifteen years have done all in their power to secure an increased factor of safety by reinforcing the thickness of the flange without an increase in the cost of the wheel to the railroad.

Increased factor of safety

From a purely theoretical consideration it is certain that a decided improvement can be made in the strength of the flange and at the same time additional service be secured. It therefore seemed highly desirable to verify these conclusions and definitely determine the amount of added factor of safety which may be secured by flange reinforcement. A series of laboratory tests for this purpose was conducted at the University of Illinois.

These tests consisted of grinding the flanges of new wheels to a condition of worn flanges of various thicknesses and to make the conclusion more definite a number of wheels were cast with half the circumference having standard flange and the other half having reinforced flange. After grinding the flange to the desired contour the wheels were placed in a testing machine and the strength of the various flanges determined. The tests clearly indicate the increased strength that can be secured by a slight reinforcement at the back of the flange and thoroughly corroborated the value of flange reinforcement indicated in the service tests recorded by the M. C. B. wheel committee. Typical results are shown in Tables III to VI inclusive.

Table III—The effect of reinforcement on new flanges (See Fig. 1)

Weight of wheel	Wheel no.	Standard strength	Reinforced strength	Increase in strength
725 lb.	158,506	78,800 lb.	113,000 lb.	50 per cent
		88,200 lb.	118,200 lb.	34 per cent
725 lb.	158,510	88,000 lb.	115,200 lb.	30 per cent
		92,800 lb.	119,800 lb.	29 per cent

Average increase—35 per cent.

Table IV—Effect of reinforcing tread and flange simultaneously (See Fig. 2)

Weight of wheel	Wheel no.	Standard strength	Reinforced strength	Increase in strength
725 lb.	158,520	82,300 lb.	138,600 lb.	68 per cent
		87,100 lb.	137,700 lb.	58 per cent

Average increase—63 per cent.

Table V—Increased strength in new reinforced flange for 30-ton cars (See Fig. 3)

Weight of wheel	Wheel no.	Cracked	Final fracture
625 lb.	632,680	54,500	91,300
		64,100	69,900
650 lb.	633,452	59,300	97,800

On two of the above tests the final fracture was through the plate and tread and not through the flange.

Table VI—Effect of flange reinforcement on worn flanges (See Fig. 3)

Distance below tread at which force was applied	Flange thickness	Breaking strength	Increased strength
.62 in.	.98 in.	35,500 lb.	
.58 in.	1.14 in.	55,500 lb.	59 per cent
.37 in.	.97 in.	58,000 lb.	
.36 in.	1.15 in.	90,400 lb.	54 per cent
.49 in.	1.12 in.	66,200 lb.	

Average increase in strength—55 per cent.

The above tests indicate clearly and decisively the large factor of safety to be secured at no expense to the railroad.

In connection with the investigation of strength of flanges, an 850-lb. wheel with reinforced flange which had been worn out in service was placed in the testing machine to ascertain the flange strength in wheels for 70-ton cars. Results were obtained as shown in Table VII and Fig. 4.

Table VII—Results of tests of 850-lb. reinforced flange wheel

Wheel number	Distance of point of application of force below tread line	Ultimatestrength of flange
107,348	1.26 in.	109,600 lb.
	1.19 in.	100,900 lb.
	1.09 in.	90,500 lb.
	.92 in.	115,600 lb.
	.77 in.	109,700 lb.
	.62 in.	138,500 lb.
	.41 in.-cracked	175,500 lb.
	Broke through plate	181,700 lb.

This table gives conclusive evidence of the advantage of reinforcing the flange of wheels under 70-ton cars.

The entire results are so positive and correspond so thoroughly with engineering experience in the strength of materials that the decided beneficial effect is beyond the realm of doubt. The record of the tests given in the above tables shows in detail the laboratory results.

Track conditions

Now that it has been shown how desirable it is to reinforce the flange the next question is to determine how much reinforcing can be secured under present track conditions. Perhaps no subject in connection with wheel

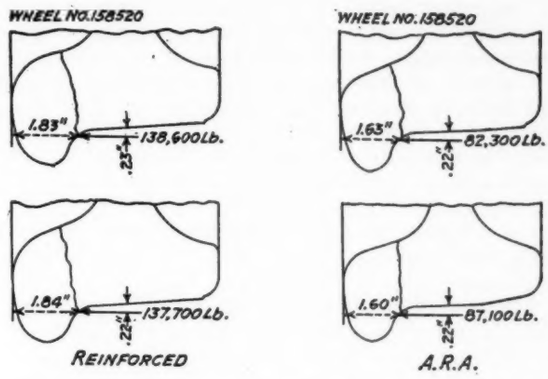


Fig. 2—Strength of new flanges with force applied ¼ in. below the tread line, with A. R. A. flange on one-half of a wheel and reinforced flange, thickened 3/16 in., and tread thickened 3/8 in. on the same wheel

design has received so careful and painstaking investigation by so large a number of experts as the subject of flange reinforcement. The history of this investigation is shown in the records of the Master Car Builders' pro-

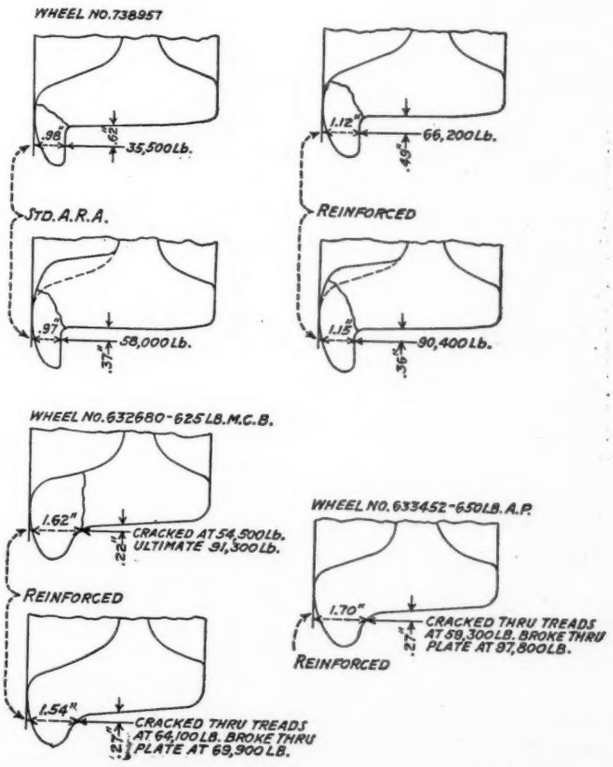


Fig. 3—Strength of worn flanges shown in the four upper sketches with force applied at various distances below the tread line—The reinforced flange is 3/16 in. thicker than the A. R. A. flange—Three lower sketches show 625-lb. and 650-lb. wheels with reinforced flanges 3/16 in. thicker than the normal A. R. A. flanges

ceedings and the proceedings of the American Railway Engineering Association.

The report of the Wheel Committee to the M. C. B. association at the 1912 convention contained the following:

"The question of increasing the thickness or the flange and mounting wheel 3/16-in. farther apart is a matter which this committee cannot pass upon or recommend. It was suggested that the Association of Manufacturers of Chilled Car Wheels refer this question to the American Railway Engineering Association as it will involve clearances in frogs, crossings, etc. If it should be found advisable after investigating this matter with the American Railway Engineering Association, the committee will report on this at some future time."

The subject was again presented by the chairman of the Wheel Committee to the M. C. B. Association at the 1913 convention, as follows:

"The wheel manufacturers have asked repeatedly to be allowed to increase the thickness of the flange 1/8 in., this 1/8 in. of metal to be placed on the back of the flange and below the tread line, or between the tread line and the center of the wheel, and your committee has not acted on this request from the fact that such increase would interfere with road conditions in regard to clearings of frogs, switches and crossings. We believe that

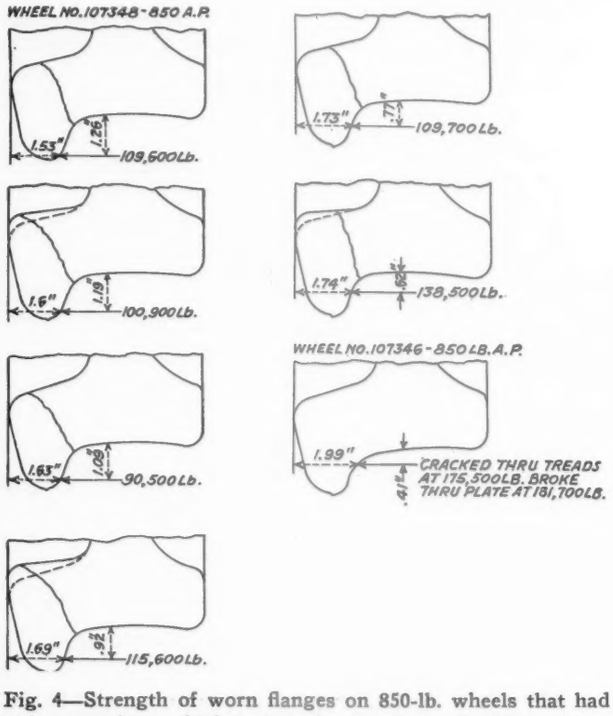


Fig. 4—Strength of worn flanges on 850-lb. wheels that had flanges 3/8 in. thicker than the A. R. A. standard, with the force applied at various distances below the tread line

with 1/8-in. more clearance in frogs, crossings and switches, the manufacturers of chilled cast iron wheels can produce a wheel that will be perfectly safe and one which will yield more economic service than any wheel on the market, and I again recommend that the matter be taken up by this Association with the American Railway Association with regard to getting an increased clearance in frogs, crossings and guard rails."

The American Railway Association refused to consider the question of increasing the clearance in frogs, crossings, etc. This, however, was not the question which the manufacturers of chilled car wheels wished to have discussed, but rather how much can the present flange be increased without interfering with present track conditions. With this understanding the American Railway Association referred the matter to the American Railway Engineering Association. A sub-committee was appointed to investigate this subject and reported as follows in the 1916 proceedings of the American Railway Engineering Association:

"The sub-committee has done some very thorough work. They came to a conclusion, but the track committee has not had time to consider it thoroughly enough to make a recommendation. The track committee sees

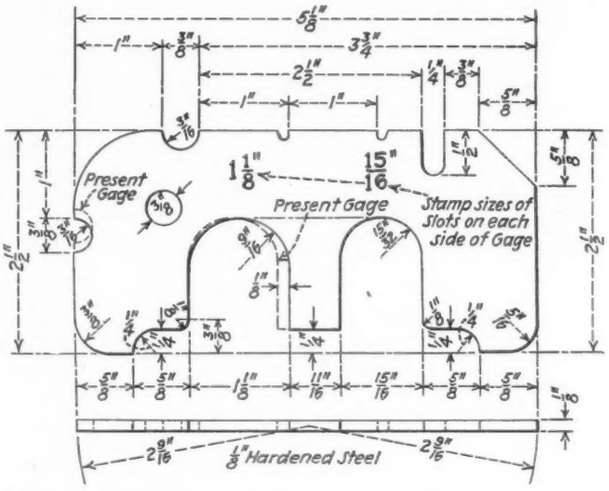


Fig. 5—Proposed wheel defect, worn coupler limit, worn journal collar and journal fillet gage

no reason why the flange of the car wheel should not be thickened as desired, and this can be done without any increase in the flangeway by closing in a little on the distance between the gage of the wheel and the gage of the track so as to allow a little less play."

The above findings of the sub-committee were made in full to the track committee, and the track committee conferred with the Master Car Builders' wheel committee which reported that nothing would be gained in the interest of safety or economy by thickening the flange as recommended. The track committee, therefore, dropped the subject. This necessitated again taking the matter up with the American Railway Association on the basis that the track committee had not reported on the subject which it was given to investigate. Another committee was appointed, which brought in its report to the American Railway Engineering Association, at its convention held in Chicago, March 18 to 22, 1918, at which time the following detailed report of the track committee was unanimously approved by the Association:

"With reference to the subject assigned to the Association by the American Railway Association and referred to the track committee relative to the contour of chilled car wheels, throat clearances for frogs, guard rails and crossings, effect of increase of thickness of wheel flanges, beg to advise that at the last meeting of the track committee held in Chicago, October 15, the chairman was directed to send you the following communication:

" 'The track committee is willing to agree that the flanges can be increased as recommended by the chilled car wheel people without any serious detriment from the track standpoint, provided:

"'First: That the wheels are, in all cases, accurately mounted to 3/16-in. additional spread gage.

"'Second: That the allowable flange wear before wheels are removed be changed so that wheels will be removed when the flange is worn to within 3/16-in. of the present limit of removal.

"'Third: That more care be used in matching wheels on any given axle on account of the reduction in play and corresponding reduction in compensation from coning.

"'Fourth: That the flange width be confined to flanges of four wheeled freight car trucks.

"'Fifth: That this conclusion on the part of the track committee be not construed as an invitation to increase the axle load.'

"With the above provisions, it is believed that it will be unnecessary to make any difference in the width of flangeway of frogs and crossings or change the present method of track construction."

The above clear-cut and definite conclusion removes all doubt as to the effect on track of increasing the flange thickness approximately 3/16-in. In fact, there is absolutely no increased guard rail interference. This is because the A. R. A. rules for mounting fix a standard distance between the throat of one wheel and the back of flange of its mate wheel, regardless of the thickness of

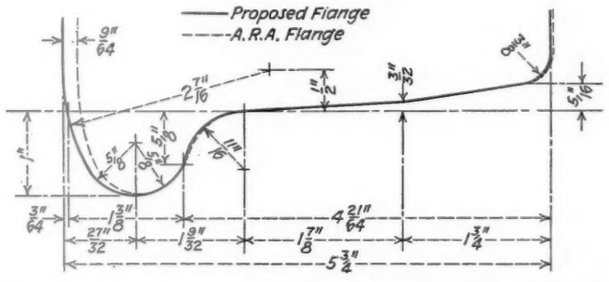


Fig. 6—Comparison of A. R. A. flange and proposed reinforced flange

flange; hence, while the throat of a wheel is crowding the rail, the back of the flange of the mate wheel is traveling at its maximum departure from its running rail, and this maximum departure is identical, regardless of the thickness of the flange, because this is the fundamental principle in mounting wheels. Therefore, it is utterly impossible for the back of the reinforced flange to wear any differently than the present standard flange.

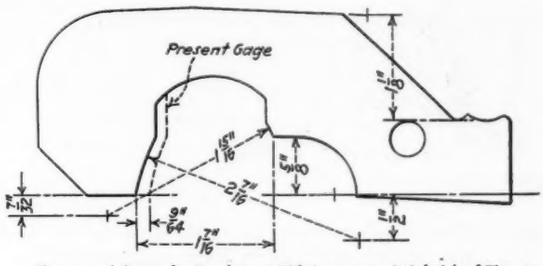
Service tests

After having received the report of the American Railway Engineering Association, the Griffin Wheel Company began the manufacture of reinforced flanges, having first secured permission from the railroad using the wheels. The popularity of their reinforced flanges has grown until at the present time there are about 4,000,000 in service having a reinforcement of approximately ⅛-in., thus demonstrating on a colossal scale that there is absolutely no guard rail interference, and no wearing at the back of the flange in any way different from that of the present standard flange. It is necessary for any flange to press against the guard rail at times if the guard rail is to serve any purpose.

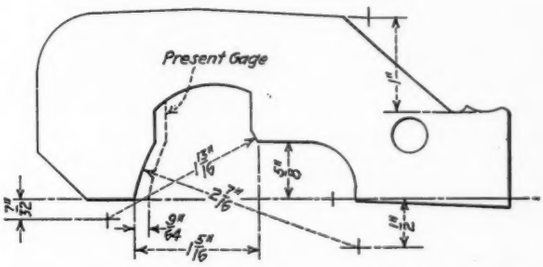
Many thousands of wheels have gone through service during the past years with a full 3/16-in. reinforcement. These can be examined in lots of a thousand or more after having given their full mileage, with no indication of having encroached upon the guard rail in any unusual manner. These results indicate that the rules of mounting in the various railroad shops are being carefully followed, for it is only in case of improper mounting that interference between flange and guard rail can occur. In fact the heavy blows on the guard rail are only possible after flanges become worn; it is the thin flange which produces guard rail interference, and not the thick flange.

Increased service

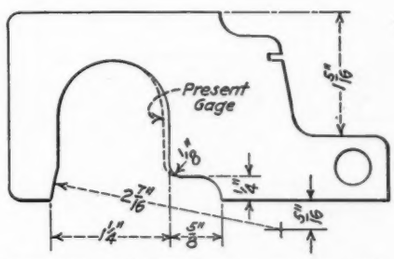
The increased factor of safety is not the only advantage of the reinforced flange. It is well known that a large amount of mileage is sacrificed by the early removal of the chilled iron wheel for various trivial causes



Proposed Gage for Maximum Thickness and Height of Flange for New Cast Iron Wheels



Proposed Gage for Minimum Thickness and Height of Flange for New Cast Iron Wheels



Proposed Limit Gage for Remounting Cast Iron Wheels

Fig. 7—Three proposed new limit gages

which are not clearly outlined in interchange rules but are left to the judgment of the inspector.

The reinforced flange will permit a revision of interchange Rule 74, whereby an increased mileage can be secured. As the rule now stands chilled iron wheels must be removed from cars of 40-ton capacity when the flange is worn ⅞-in. vertical, while all other wheels are allowed to wear 1-in. vertical before removal.

More wheels are removed for sharp flanges than for any other cause, therefore the limit of wear should be very carefully considered and the reason for the rule well established. Wheels having vertical flanges are removed on account of the tendency, when in this condition, to climb curved worn rails or split worn switch points. Chilled iron wheels under cars of 30 tons capacity and all steel wheels are allowed to remain in

service until the flange is worn 1-in. vertical. It is thus apparent that there is no relation between a wheel having a flange that is 7/8-in. vertical as far as rail climbing is concerned.

The removal of wheels for vertical flanges has no relation to the factor of safety in the flange itself, for another gage is used to remove wheels that reach a maximum of 15/16-in. thick under 30-ton cars and 1-in. thick under cars of 40 and 50-ton capacities. However,

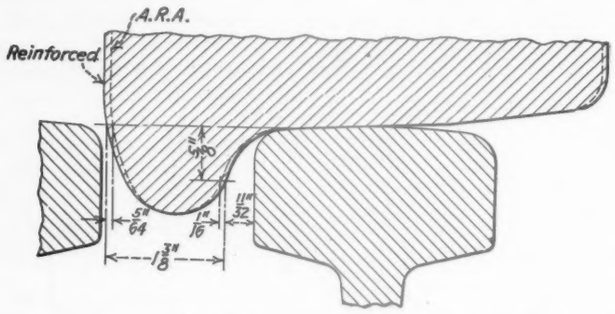


Fig. 8—Composite showing the relation of the A. R. A. and the reinforced flange to main and guard rails

for some reason or other a discrimination was made when the 40 and 50-ton cars came into existence whereby wheels for these capacities were not allowed to remain in service until worn to the same extent that is allowed wheels of lighter capacities. Evidently the factor of safety in a worn flange had something to do with the formation of the rule. This being the case, the proposed reinforcement removes all the doubt regarding the factor of safety, and instead of allowing the flange under 40 and 50-ton cars to remain until worn to 1-in. thick, they may be removed when reaching 1⅛-in. thickness and still permit of wearing 1-in. vertical.

The A. R. A. Wheel committee's report for 1926 illustrates how many flanges are condemned on account of improper application of the gage to treads which are worn hollow. This is a very important item in connection with increased service. In most instances 20 per cent more wearing value of the flange and tread could be secured if Rule 74 was revised as suggested, in which case it would read:

> Wheels with flanges having a flat, vertical surface extending 1 in. or more from the tread—for flanges of chilled iron 1⅛ in. thick or less, for steel wheel flanges 15/16 in. or less, etc.

The wheel defect gage will require modification to agree with this rule by the elimination of the 7/8-in. gage for vertical flanges and increasing the gage for thin flanges from 1-in. to 1⅛-in. as shown in Fig. 5.

Revision of flange contour

In choosing the amount of increase to which there can be no objection from any source, and also in fixing dimensions which eliminate all small fractions from the ruling dimensions and remembering that the usual tolerance of 1/16-in. above normal will be retained, it has been decided that an increase of 9/64-in. will fulfill all requirements. This increase is 3/64-in. less than agreed to by the track committee which will take care of the variation in casting. The flange thickness as proposed above becomes: Maximum, 1 7/16-in; normal, 1⅜-in.; minimum, 1 5/16-in. Fig. 6 shows all the dimensions of the proposed flange.

Maximum and minimum flange gages for the proposed flange are shown in Fig. 7. They are simply 9/64-in. larger than the present standard, or in other words, the present maximum becomes practically the proposed minimum.

Limit gage for remounting

Fig. 7 also shows a proposed revision in the limit gage for remounting chilled iron wheels, whereby the minimum thickness for second hand wheels is 1-in. for all capacities, thereby eliminating the remounting gage for wheels under 30-ton cars. This will allow 1/16-in. more wearing value before second-hand wheels can be condemned. The object should always be to conserve all good material for more service. A campaign along these lines can easily secure 20 to 40 per cent more mileage than is now obtained from chilled iron wheels, at the same time provide a decided increase in the factor of safety.

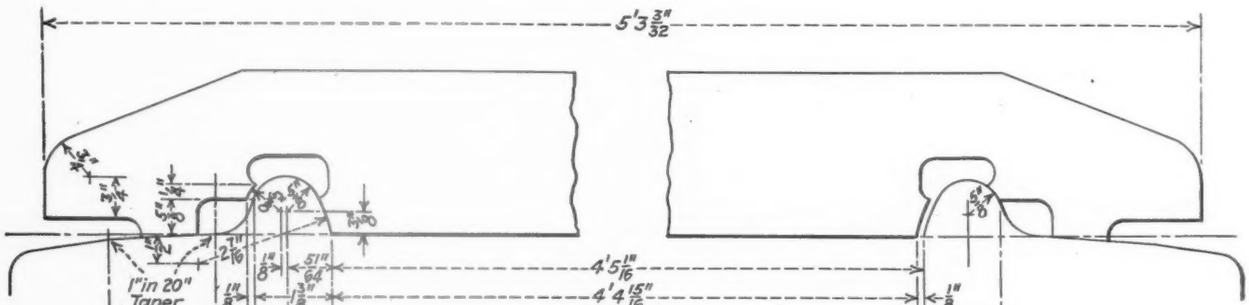


Fig. 9—Wheel mounting gage

Mounting gage

In order to remove the 1/64-in. from the mounting gage dimensions, the check gage distance, which is the most important of all dimensions in mounting, should be made 4 ft. 6 7/16 in. The code of rules governing interchange still contains a cut showing that for wheels cast prior to 1907 the check gage distance must not be more than 4 ft. 6¾ in. This indicates that the check gage distance has been reduced 19/64-in. since 1907, hence 1/64-in. more or less at the present time has no appreciable effect on the relation of wheels to track. Using a check gage dimension of 4 ft. 6 7/16 in. the mounting dimensions become:

	Throat to throat	Back to back
Maximum	4 ft. 7-7/16 in.	4 ft. 5 in.
Normal	4 ft. 7-1/2 in.	4 ft. 5-1/16 in.
Minimum	4 ft. 7-3/4 in.	4 ft. 5-1/8 in.

In arriving at definite conclusions, the following facts must be taken into consideration.

1—Wheel loads are now five times greater than they were when the contour of the flange was first standardized.

2—Records everywhere indicate the correctness of technical deduction that the stress in the flange increases in a direct ratio as the wheel load increases.

3—Three-sixteenths of an inch of metal added to the back of the flange will increase the strength of worn flanges 50 per cent.

4—The A. R. A. investigation reported that thickening of the flange 3/16-in. will not interfere with present track clearances.

5—Millions of wheels in service with reinforced flanges prove conclusively that there is no track interference on acount of flange thickness.

6—A 50 per cent increase in strength of worn flanges can be secured without additional cost to the railroads.

7—An additional mileage in heavy service of 20 per cent to 30 per cent can be secured with a corresponding reduction in shop costs.

The fact that the recommended flange will result in a decided improvement in the chilled iron wheel, in economy and safety without expense to the railroads, is a sufficient reason for its universal adoption. There is no greater service that can be given the railroads of America in connection with improvement in the chilled iron wheel than immediately to standardize the reinforced flange.

Maintenance of passenger car brakes*

By W. D. Herndon
Air brake foreman, Jacksonville Terminal Company, Jacksonville Fla.

WHEN passenger cars are shopped for air brakes, the triple or control valves should be removed from the car and taken to the air room where they are cleaned on a bench provided for that purpose. This bench should not be used for any other work. The valve should be dismantled and thoroughly cleaned with gasoline, all ports and passages blown out with compressed air and all parts thoroughly inspected. All defective gaskets should be scrapped. Emergency rubber seats should be removed whether defective or not. After the valves have been cleaned, they should be lubricated with pure graphite. No oil should be used on triples or control valves. A good grade of rags should be used instead of waste.

After the triple or control valves are cleaned and assembled, they should be placed on the standard test rack and tested according to the standard code of instructions; soap suds should be used during this test. Valves that do not pass the required test must be repaired before being placed in service. Train pipe strainers should be cleaned at the same time as the triple or control valve and also the air and signal hose given a soap suds test, and any porous hose removed and sliced with a knife.

Safety and high speed valves must be cleaned, tested and adjusted. The water system governor and reducing valves must be cleaned and tested, the governors set to open at 60 lb. and the reducing valves set to maintain 18 lb. pressure in the water system. The signal line and discharge valves must be tested for leaks and all leaks found must be repaired before the car is released for service.

The cylinders must be thoroughly cleaned and lubricated with a good grade of brake cylinder lubricant, being careful not to use too much. The slack adjuster cylinders should be given the same attention as the brake cylinder and the brakes properly adjusted to 7-in. piston travel. Foundation brake gear should be carefully inspected for foul levers, worn key bolts, etc. Dirt collector caps should be removed and the dirt collectors blown out.

After all this work has been done, the car should be tested with a single car testing device and pass all tests before the car is released for service. This single car testing device should be used on all cars before being released from the repair tracks, whether they were sent there for air brake repairs or not, and if they do not pass the test, they should be carded for repairs, regardless of the dates on the car.

A very important test with the single car testing device is to see if the brakes will apply with a 10-lb. reduction when the valve is in position No. 4. In a great many cases the brakes will not apply in this position, owing to combined leakage through cylinder packing and leakage grooves. This happens mostly with the old PM equipment and should not be mistaken for triple valve defects. This trouble, however, is not likely to happen with the quick service triples.

Defects in UC valves

We have experienced a lot of trouble with the older types of emergency pistons bending and binding the rings in the ring groove, and in a great many cases causing the pistons to become inoperative. On one occasion we had a UC valve giving trouble on account of going in emergency on a service application. When this valve was placed on the test rack, I found that when a service application of 6 or 7 lb. was made, the valve would go to emergency, but did not vent brake pipe pressure to the atmosphere. When the valve was dismantled, I found the emergency piston bent and stuck in emergency position. While this valve was being tested, we did not get any air in the quick action and quick action closing chambers.

The reason for this valve giving an emergency application on this car was that when the brakes were applied, the release slide valve moved to application position and connected the bottom of the high pressure valve with the atmosphere through the emergency slide valve. This connected the back of the intercepting valve momentarily to the atmosphere. The service reservoir pressure, being present on the face of the intercepting valve, caused the intercepting valve to open and pass service reservoir pressure to the brake cylinder and, as the brake cylinder pressure was present on the spring side of the intercepting valve, the spring closed the intercepting valve. This in turn caused emergency reservoir pressure to flow to the brake cylinder, giving a high brake cylinder pressure.

Emergency piston rings

If I remember correctly, the Westinghouse Air Brake Company does not give any test for emergency piston rings, and I have found considerable trouble with worn emergency piston rings. I find that a badly worn emergency piston ring will cause a blow at the emergency slide valve exhaust port when the valve *A* on the test rack is returned to lap position after making a reduction

* Paper presented at the July 16, 1926, meeting of the Southeastern Air Brake Club, Atlanta, Ga.

in brake pipe pressure. This is due to the ring leaking and the piston will not return back to its former position. This caused the quick action chamber pressure to be reduced. That in turn causes the brake pipe air to be reduced by the amount of air that the packing ring is leaking.

Blow at emergency exhaust port

Not long ago I had a UC valve cut out on the road because the emergency rubber seated valve would not seat after an emergency application. This valve was placed on the test rack and I found that it would not seat after an emergency application, and I had a blow at the emergency port when we returned the valve *A* to release position. On examination, I found that brake cylinder pressure was flowing from the emergency slide valve chamber down underneath the quick action piston, raising the quick-action piston and holding the emergency rubber seated valve from its seat, causing train line pressure to escape to the atmosphere. This was due to a plug being loose in the side of the emergency slide valve.

I am mentioning these facts to impress upon your mind that a man, to become a successful test rack operator, must first understand the operation of the valve.

Other trouble we have with the UC valve is the protection valve getting grit in it and failing to return to its atmospheric seat after an emergency application. The best remedy I know of is not to use any lubricant on this valve at all; although I have found that pure graphite does not do any harm when applied properly. I should also like to mention that I find about 50 per cent of the UC valves in service when tested fail to take the protection valve test on the test rack.

We use a portable test truck for train yard testing; you can use this truck on any length of passenger train up to 20 cars. When testing trains in a train yard any cars that will not pass the test with the portable test truck are sent to the repair track for repairs. We also use this test truck on cars that are reported as defective before they are sent to the repair track.

Testing steam hose couplings

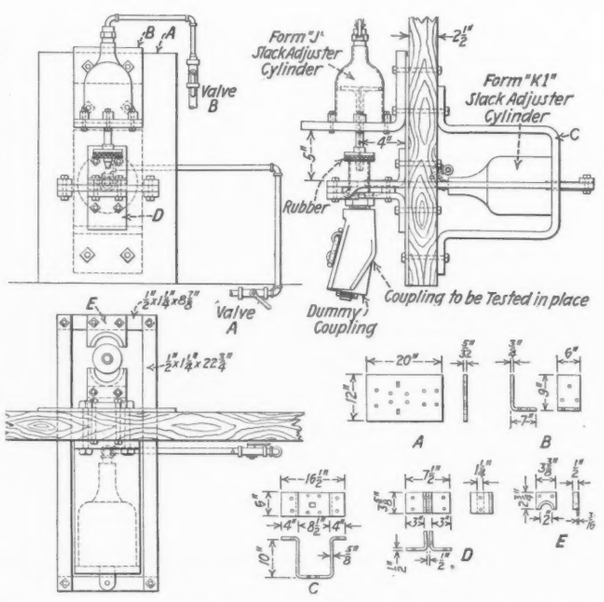
By Thomas Birch

Air brake foreman, C. M. & St. P., Milwaukee, Wis.

A CLOSE analysis of the situation emphasizes the real economy of testing steam hose couplings before remounting in new hose. There is one defect in particular that is almost impossible to detect and, in a large number of cases, is not noticed until a complete failure takes place. This is a fracture on the under side of the nipple where it tightens up in the coupler head, undoubtedly caused by failing to chain up the hose in switching movements and thereby permitting the coupler to strike the rail when making cross-over movements. The number of these defects is surprisingly large, averaging about eight per cent of all the hose handled. This fracture is not readily evident when submitting the hose to steam pressure because the heated metal expands and temporarily closes the crack, but if air pressure was used for testing purposes, the leak would be instantly obvious to the observer.

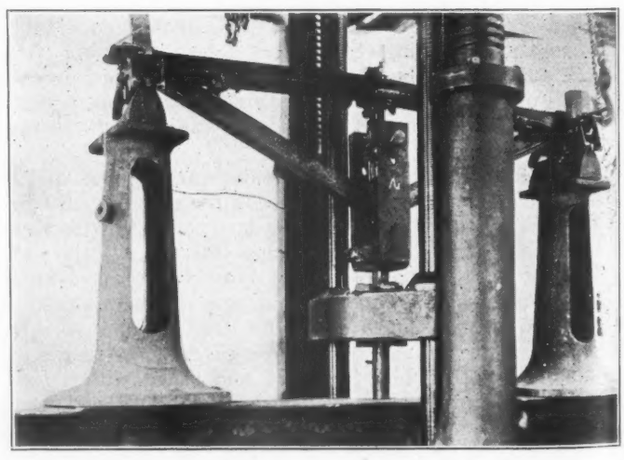
With this knowledge we designed a device as shown in the illustration which, since its installation, has proved very efficient and has disclosed many defects that would otherwise have re-entered actual service. Using an air pressure of about 90 lb., we are also able to obtain a fairly accurate knowledge of the condition of the gasket and the locking features of the coupler.

The drawing is in such detail as to make the construction and the operation of the device easily understood. A dummy coupling is attached to the coupling that is to be tested, and the nipple that is already in place in the coupling is set on the lower half of clamp *E*. Valve *A* is then opened permitting air to flow to the *K-1* cylinder, this causes the upper half of clamp *E* to move down and securely clamp the coupler head in place. Valve *B* is then opened permitting air to flow to cylinder *J*. This forces outward the piston on the end of which is a substantial rubber gasket that seals the end of the nipple. There is a small hole drilled through the entire length of the piston through which pressure flows into the coupling simultaneously with the sealing of the nipple.



Steam hose coupling testing device which discloses many defects

A liberal use of soapsuds is then resorted to in looking for defects.



Bending and deflection tests of brake beams on a 200,000 lb. Riehle testing machine at Purdue University

Accident prevention at Enola steel car shop

Workmen must not be coerced into but sold to the idea of safety first—Advertising principles used

ON page 97 in the February, 1926, issue of the *Railway Mechanical Engineer* appeared an article descriptive of the shop layout, organization and methods of rebuilding steel cars at the Pennsylvania System Enola steel car shop, located about five miles from Harrisburg, Pa. The output averages consistently 36 cars per day.

There are many industrial hazards to be found in a steel car repair shop which are conducive to accidents if the men are not properly trained, both mentally and physically, to guard against them.

Those in charge of the "safety first" movement at Enola are aware of these conditions and naturally realize the increased responsibility in trying to reduce accidents to a minimum, but have not lost sight of the fact that the workman is responsible for accidents in most cases and he, therefore, is the one that must have the supervisor's almost constant attention. He must be taught to accept the conditions as they exist and train himself to a realization of the apparent danger and use the necessary precaution to master danger or eventually be dropped from the service.

Conditions faced at the opening of the shop

At the opening of the Enola shop there were about 250 men available who had previous experience in repairing cars by the old method. Their experience helped insofar as getting out the work was concerned, but by transferring these men to strange locations and conditions, together with a new system of doing the work, it added to their difficulty in the mastery of danger.

To obtain the desired production of 36 cars a day, it was necessary to employ about 620 additional men who with a few exceptions, were inexperienced at any kind of skilled labor. Employing and breaking in such a large number of men in a short period of time was more difficult than the installation of 620 machines for the reason that machines can have safeguards applied as soon as installed. With the human machine it is quite different. The men can be furnished with goggles and acquainted with safety rules, but unless they see the importance of wearing goggles and obeying the rules, they will not be safeguarded.

Left—One of the effective "safety first" signs painted on the wall and the safety honor roll near the toilet door; Right—The shop's slogan painted over one of the office windows

The best way to guard a workman is to sell him the safety idea which generally requires a great deal of time, effort and determination on the part of the supervision, as no man is sold to the safety idea until he realizes the importance of preserving life, limb and property.

It required five months to increase the force to 870 men during which time there, naturally, was a very large turnover of labor which did not minimize the accident hazard.

Method of selecting men for employment

If the applicant for employment appears physically capable, he is given a general outline of the work he will be expected to perform. After inquiring as to his ability, previous experience and where acquired, he is questioned as to what he knows about "safety first" and if he

believes in it, the number of times he has been injured or has injured others during the past three years. He is also questioned as to what action he would take if confronted with certain dangerous conditions.

If his answers are satisfactory, he is accepted and is requested to help put over a 100 per cent no accident record each month and at the same time is given to understand that in order to remain employed he must divorce himself from carelessness. He is instructed to report for duty with gloves and heavy-soled shoes and told why in detail. Experience is a great teacher, but no workman should be allowed to experience a costly accident before learning details. By taking care of details, the job will take care of itself.

Means employed for training men

When the new man reports for work, he is first given an instruction book for the guidance and protection of new and inexperienced employees. He is given goggles, if the nature of his work requires them, for which he acknowledges receipt in writing. He is then introduced to his gang foreman who gives him instructions in a general way regarding cleanliness and order in his work and about the premises, gives him an outline of the nature of his work, acquaints him with the details of his job, and instructs him how to avoid accidents.

The new workman is then introduced to the men with whom he will be assigned to work. The gang foreman

An effective method of preventing the workmen from running from the work train across the tracks to the shop

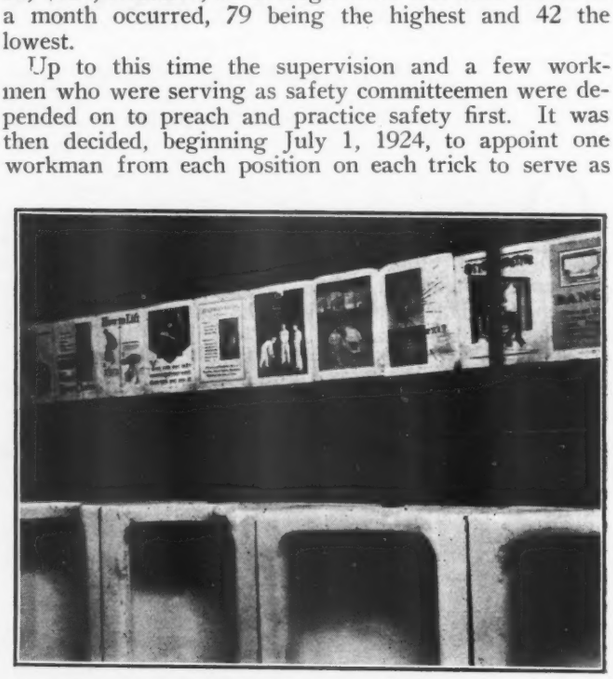
establishes as friendly relations between them as possible and gives the new man more than ordinary supervision and attention the first few weeks, in order to observe how he is progressing and give him necessary instructions. After that he is given the same supervision as the other workmen.

When new men are employed in numbers, they are placed under a competent instructor for a reasonable length of time. As all men are not adapted for the same job it is necessary to drop some of them. Teaching a man to perform the actual labor is a small matter compared with getting the safety idea into his mind.

Accident record

From July 23, to December 31, 1923, an average of 31 lost time accidents a month occurred, 43 being the highest and 17 the lowest. From January 1 to June 30, 1924, inclusive, an average of 58 lost time accidents a month occurred, 79 being the highest and 42 the lowest.

Up to this time the supervision and a few workmen who were serving as safety committeemen were depended on to preach and practice safety first. It was then decided, beginning July 1, 1924, to appoint one workman from each position on each trick to serve as



These "safety first" bulletins are sure to be read

a safety committeeman for a period of one month. This increased the number of committeemen to 34. The foreman holds a two-hour monthly meeting with these men for which time they receive compensation. Their duties are to preach and practice safety first and report all dangerous conditions and practices which come to their notice. They are also to do all in their power to convert the workmen to the "safety first" idea. By having 34 workmen on a committee of this kind and changing them monthly, eventually the foreman has an opportunity to consider safety problems for at least two hours with every man in the shop.

The first thing considered was whether the most careful or most careless man in each position should be appointed on the committee. It was decided on a 50-50 basis. By so doing there were 17 careful workmen to help sell the safety idea to the 17 who were more or less thoughtless or negligent.

At these meetings, the accidents of the previous month are reviewed and thoroughly discussed. Suggestions are invited and when any are made, the employees who make them, in company with the foreman, investigate them directly after the meeting has adjourned.

Where there is any merit, action is immediately taken and the men given proper credit. Prompt action in such cases may not only prevent an accident the following day, but cause the men to feel that their suggestions were of importance.

It was considered a good idea to have one or two of the men read a short article from a magazine on safety even if material had to be furnished for them. This creates the impression among the other committeemen that some are taking more interest than others and gives them a desire for more knowledge about safety. Another successful plan was to praise the work of the previous committee and give them credit for everything they had

accomplished during their service as committeemen.

These meetings give the foreman a splendid opportunity to present other matters pertaining to the shop and company policies. They also tend to increase the spirit of co-operation and create a better understanding between the supervisors and workmen.

For the first ten months that this committee functioned, there was a total of 393 lost time accidents or an average of 39.3 per month compared with the previous ten months when there was a total of 477 lost time accidents, or an average of 47.7 per month. This shows a decrease of 17.6 per cent for which the members of the committee were given due credit.

During April, 1925, there were 12 lost time accidents as compared with 51 for the corresponding month in prior when there were a total of 307. This made a reduction of 291 lost time accidents, or 94.8 per cent.

The following statement shows the accidents which occurred at the Enola steel car shop during 1925:

January	34
February	31
March	24
April	12
May	0
June	1
July	1
August	2
September	1
October	5
November	1
December	7
	119

One day absent from duty constitutes a lost time accident.

Lower left—A grim relic of the war tied up to the hazards of carelessness; Upper left—All three tricks hit the bull's eye for the month of May; Right—The popular game of baseball and an empty barrel used to stimulate interest in safety

1924. It was now felt that "Old man accident" was about winded and all that was necessary was to go after him in May and give him a knock-out blow, which was done by having a 100 per cent no-lost time accident month.

During this month, with no lost time accidents, 127,860 man-hours were worked, 750 cars repaired, an average of 825 men employed, 1,340,250 rivets driven, 6,886,000 lb. of scrap reclaimed, 7,642,800 lb. of new material applied to cars and 2,288,000 lb. of steel removed, straightened and reapplied.

From May 1 to Dec. 31, 1925, there were a total of 16 lost time accidents as compared with the eight months

Some of the methods employed during May, 1925, and since to sell the safety idea

After the fine showing made during the month of May, all supervisors, safety committeemen and the majority of the workmen tackled the job with renewed energy and enthusiasm. The following slogan was adopted: "Less accidents or less employees."

In order to make the slogan effective, it was necessary to dismiss five employees from the service because of continual carelessness. It later developed that one of these employees who was working at the shop on the night shift was cultivating, during the day, a 30-acre

farm on which he lived. This explained the cause of his numerous accidents.

The successful business man knows the true value of advertising. In selling the safety idea, advertising was one of the chief factors. Safety signs were placed about the shop layout at every feasible point which would be seen by the workmen. The signs which were permanent were, at intervals, moved from one place to another so that all the men would have an opportunity to read them. A few of these signs are shown in the accompanying illustrations.

The following notice was painted on the wall of the office in such a location that the attention of all persons entering was immediately attracted to it.

TO MEN SEEKING EMPLOYMENT

UNLESS YOU ARE WILLING TO BE CAREFUL TO AVOID INJURY TO YOURSELF AND FELLOW WORKMEN, DO NOT ASK FOR EMPLOYMENT. WE DO NOT WANT CARELESS MEN IN OUR EMPLOY.

Another notice on the wall of the office directly over the first aid cabinet reads as follows:

ALL THOUGHTFUL EMPLOYEES WILL AND OTHERS MUST REPORT PROMPTLY TO THIS OFFICE AND RECEIVE FIRST AID ATTENTION, REGARDLESS OF HOW SLIGHT THE INJURY MAY BE CONSIDERED. WE MAY PREVENT, BUT WE CANNOT CURE LOCK-JAW OR BLOOD POISONING.

The following permanent notices were painted on tin in large letters and displayed about the shop in conspicuous places.

CARELESS EMPLOYEES ARE DANGEROUS EMPLOYEES, DANGEROUS EMPLOYEES ARE UNDESIRABLE EMPLOYEES, UNDESIRABLE EMPLOYEES WILL NOT BE ALLOWED TO REMAIN IN THE SERVICE. A WORD TO THE WISE IS SUFFICIENT.

Every man in the shops read the following notice:

The man who is careless and knows that he is careless is a fool—Avoid him.

The man who is careless and does not know that he is careless is simple—Teach him.

The man who is careful and does not know that he is careful is asleep—Arouse him.

The man who is careful and knows that he is careful is a wise man—Follow him.

The sentiment expressed in this notice is as it should be:

THE CARELESS MAN CAN RECEIVE FIRST AID IN THE OFFICE, BUT NO SYMPATHY WHATEVER.

Another notice, which appears over the tool room window tells the object of "safety first" in a nut-shell.

SAFETY FIRST
MEANS FEWER
WIDOWS, ORPHANS AND CRIPPLES
AND LESS . .
DESTITUTION AND MISERY

The following slogan is painted on the bridge of the 15-ton crane.

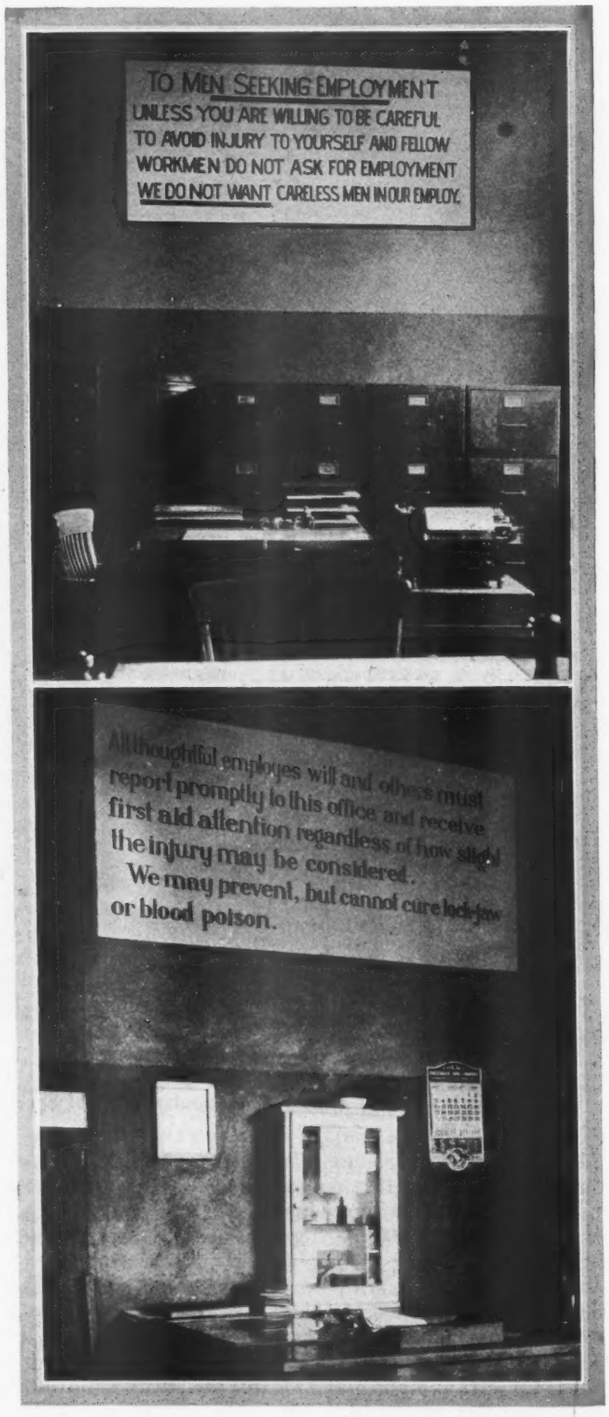
SAFETY IS THE DEVELOPMENT OF A MENTAL ATTITUDE. CARELESSNESS IS THE SAME THING.

Six 9-in. by 12-in. posters taken from the National Safety News are displayed on bulletin boards back of each drinking fountain. Twenty posters of the same size are placed directly over the urinals in the lavatory. One large and four small posters are placed in each of the eight coaches of the workmen's train. These posters are changed from time to time.

A large covered mirror was placed in the locker room with the following wording on the cover which hangs over the front of the mirror

UNDER THIS COVER YOU WILL FIND THE MAN WHO IS MOST LIKELY TO INJURE YOU, NOT INTENTIONAL, BUT THROUGH BEING THOUGHTLESS OR CARELESS, RAISE THE COVER AND LOOK HIM OVER.

A safety honor roll has been placed in the shop in an attractive cabinet with the following introduction, signed by the foreman:

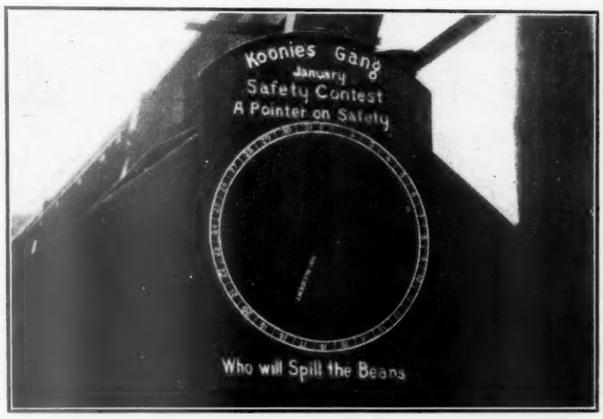

TO MEN SEEKING EMPLOYMENT
UNLESS YOU ARE WILLING TO BE CAREFUL TO AVOID INJURY TO YOURSELF AND FELLOW WORKMEN DO NOT ASK FOR EMPLOYMENT
WE DO NOT WANT CARELESS MEN IN OUR EMPLOY.
All thoughtful employes will and others must report promptly to this office and receive first aid attention regardless of how slight the injury may be considered.
We may prevent, but cannot cure lock-jaw or blood poison.

These two signs are located in the foreman's office so that they must be seen by those seeking employment

THE FOLLOWING MEN HAVE WORKED DURING THE YEAR 1924 AT THE ENOLA STEEL CAR SHOP WITHOUT CAUSING A LOST TIME ACCIDENT TO THEMSELVES, OR OTHERS. THIS IS A VERY CREDITABLE SHOWING AND THE MEN ARE HEREBY COMMENDED.

There were a total of 477 names shown on this roll for 1924, and 791 for 1925.

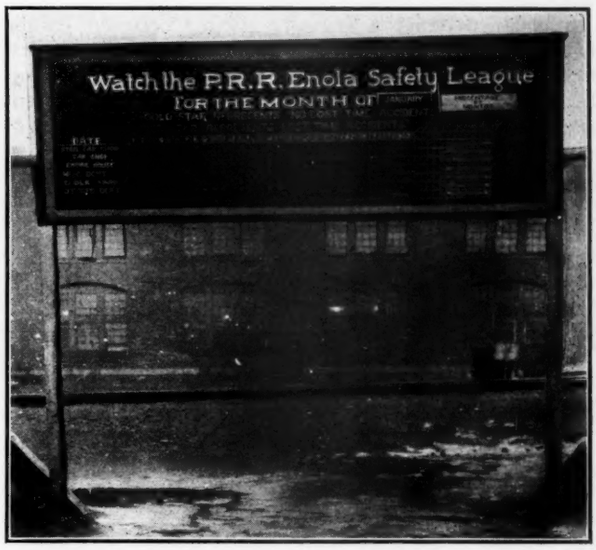
A 30-in. by 30-in. banner is carried about the shop at different times on which is painted safety slogans or other information regarding the "safety first" drive that is being tried to be put across to the men.



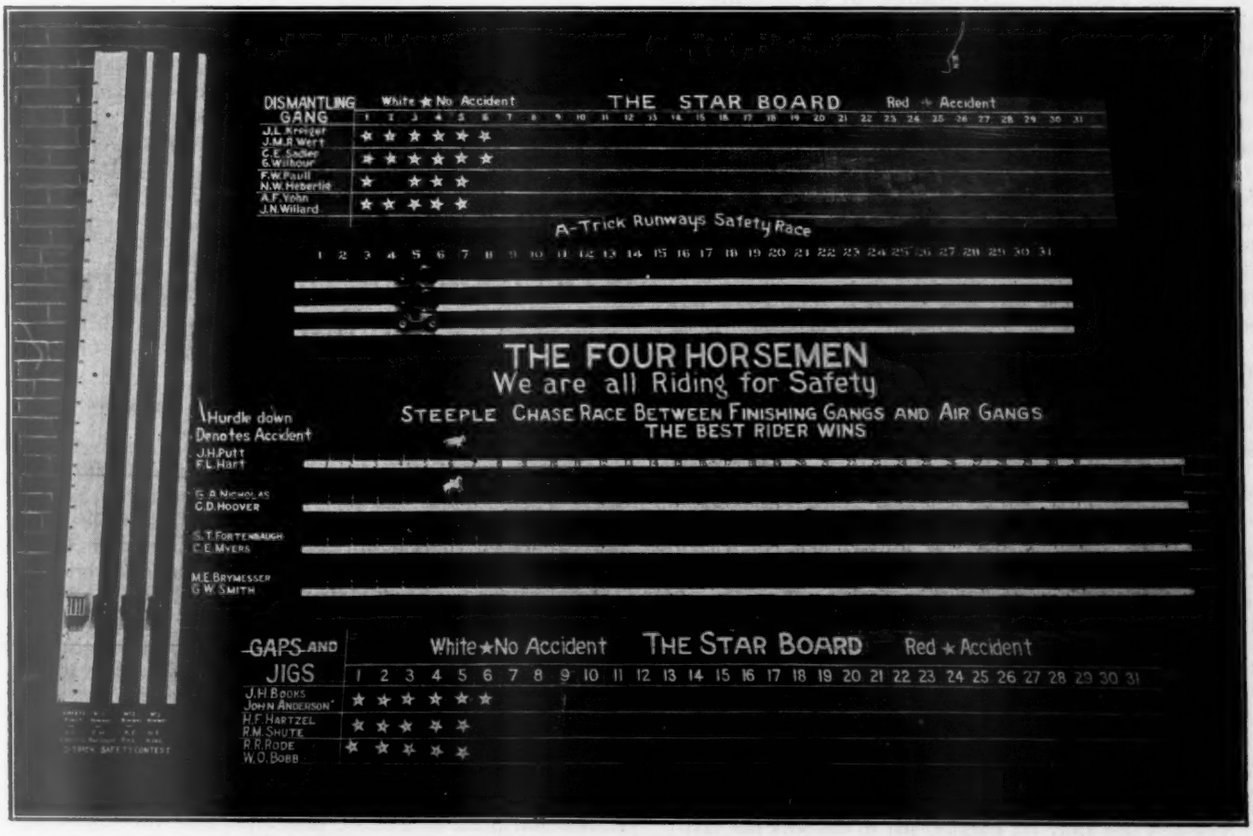
A "safety first" contest board located in the reclamation yard

In the morning the men detrain from the workmen's train about 250 ft. from the shop. Employees riding this train must cross three tracks and a 6-in. air line extending about 10-in. above the ground level. To break up the dangerous practice of employees running from the train to the shop, speed trap signs were erected readings: "Speed trap, limit four miles per hour." The novelty of this sign appealed to the workmen.

A barrel placed on the outside of the office, above which the following notice was placed, "Before going to work, deposit all careless habits here. By orders of Safety Committee." Every employee must pass this barrel at least once each day. It is believed that this stunt prevented a barrel of trouble.



This sign is located at the main entrance to the shop enclosure


THE STAR BOARD
DISMANTLING GANG
White ★ No Accident
Red ★ Accident
A-Trick Runways Safety Race
THE FOUR HORSEMEN
We are all Riding for Safety
STEEPLE CHASE RACE BETWEEN FINISHING GANGS AND AIR GANGS
THE BEST RIDER WINS
Hurdle down Denotes Accident
GAPS AND JIGS
THE STAR BOARD

A group of the various star and race boards used to arouse interest in the safety movement

An 8-in. high explosive shell, 28 in. long was found in the scrap pile. It was painted and lettered as follows: "War is hell. So is carelessness. See the point?" This was located on the ground outside the office. To some this particular bit of advertising seemed insignificant, but in the words of the foreman "It helped to pierce the armor of some of our thickskinned, hard-boiled, careless employees."

In order to start a friendly rivalry between gangs, such devices as automobile, hurdle and elevator races, workmen climbing ladders, star boards, etc., were adopted. These devices showed the progress of the different gangs and helped stimulate interest in the safety movement.

To show progress by tricks, use was made of a bull's eye painted on a board with one arrow for each trick. The location of the arrows in the bull's eye showed the monthly results.

The object in view in adopting the above mentioned methods was to keep the safety idea constantly in the minds of the workmen. It was believed that the best results could be obtained by starting with a few and adding something new from time to time to stimulate interest.

Keeping in touch with careless or indifferent employees

The following notice, signed by the foreman, was posted on May 1, 1925.

> ANY EMPLOYEE WHO LOSES TIME HEREAFTER ON ACCOUNT OF AN ACCIDENT WILL BE CALLED ON AT HIS HOME BY A COMPANY PHYSICIAN AND A REPRESENTATIVE OF THIS SHOP THE FIRST THREE DAYS AFTER HE STARTS TO LOSE TIME.

From May 6 to December 31, 1925, the foreman or one of his assistants, accompanied by a company physician when necessary, called at the homes of 62 employees who had received minor injuries and failed to report on their following tour of duty or who failed to report an accident at the time it occurred and reported off duty the following day by telephone or through another employee.

Upon investigation it developed that the injuries of four of these employees were of such a nature that it was necessary for them to remain off duty one or more days. In several cases where sprains were reported, the diagnosis of the company physician proved them to be lumbago. In other instances it was learned they were off duty on account of business or illness of one of their family.

Where employees had remained from duty unnecessarily on account of a slight injury, they were induced to return to the shop and resume duty at their regular occupations. While this method is still in force, it is seldom that it must be resorted to.

About wearing goggles

A great deal of difficulty was experienced in getting some of the men to see the importance of wearing goggles when their work was of such a nature as to require them. Among other things, they were subjected to ridicule by posting poetry such as the following:

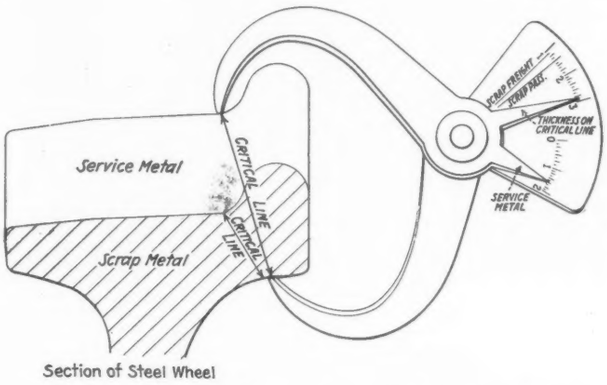
NED NEARLY

Ned Nearly was very careful, to this you'll all agree,
He always wore his goggles, but not where they should be.
He wore them on his forehead, he wore them on his clothes,
But no one can remember, that he wore them on his nose.
One day a piece of steel, came flying toward his eyes,
Ned was busy working, and it took him by surprise.
On his cap he had his goggles, the steel went in his eye,
Now he's laid away his goggles, and to the boys has said
"Good-by"

Calipers for measuring steel wheels

IN order to determine the amount of surface metal before and after turning a pair of wheels, they must be measured on the critical line which is the thinnest point in the throat of the flange. In order to determine the amount of service metal with a standard A. R. A. steel wheel gage, it is necessary to subtract from the total thickness on the critical line 1⅜-in. for passenger and 1⅛-in. for freight car wheels.

Owing to the difference in the radius on the underside of the various makes of wheels, it is impossible to



Method of using calipers for measuring steel wheels

get the correct reading at all times. By using the calipers shown in the illustration, the critical line is easily found which is indicated by the long pointer which shows the thickness of this line. This pointer also shows when both freight and passenger car wheels are worn to the scrap limit.

The short pointer begins to register the amount of service metal after the long pointer passes by the scrap limit, thus all measurements are shown at the same time without the necessity of subtracting the scrap metal from the total measurement of the critical line.

Decisions of the Arbitration Committee

Stencilling charges for triple valves

On February 20, 1923, the Southern Pacific cleaned and tested the cylinder and triple valve on N. O. T. & M. box car No. 686, at which time they removed a New York H-1 triple valve and applied a K-2 triple valve and stencilled the car for a standard, K-2 triple valve, charging the car owners $30.40 for the difference in value of a non-convertible valve removed and A. R. A. standard valve applied, and 0.5 hr. labor for stencilling the car. On June 30, 1923, the Gulf Coast Line returned the repair card to the Southern Pacific objecting to the charge of $30.40 on the grounds that the car was built during 1907 and the charge should be reduced to $11.30, the conversion price, in accordance with Interpretation No. 6, Rule 17, which states that on cars built prior to January 1, 1915, the charge shall be on the basis of the conversion price of $11.30, plus allowance for removing, repairing and replacing triple valves, as per Item 29 of

Rule 111. The Southern Pacific refused to confine the charge to $11.30 as requested by the Gulf Coast Lines, claiming that the car was stencilled "rebuilt 2-21" and that the rebuilt date should govern the charge for the change of triple valves.

The Arbitration Committee in rendering its decision stated that according to the evidence presented, the car did not bear stencilling showing the date built prior to January 1, 1915. The bill of the Southern Pacific is sustained.—*Case No.* 1356, *Gulf Coast Lines vs. Southern Pacific.*

Damage caused by a defect on another car

On January 7, 1923, M.-K.-T. 60,000-lb. capacity wooden box car No. 88562 received extensive damage while in the possession of the Indiana Harbor Belt at its Blue Island station. Defects on this car developed while a locomotive was shifting a cut of 19 cars, consisting of 18 loads and one empty, the first out being the car in question. This car was kicked onto a track and when the engineman attempted to stop, the other 18 cars broke off next to the locomotive, ran down the track and struck M.-K.-T. car No. 88562, resulting in damage to five longitudinal sills, two end sills and two crosshead members, together with various other minor defects. After the car was repaired, a bill amounting to $318.31 was presented to the car owner. The owner road refused to pay the bill, claiming that the handling line was responsible for the cost of these repairs, basing its contention on provisions of Paragraph E, Rule 32 of the 1922 Revised Code of Rules, which provides that the handling line shall be responsible for defects developed on account of handling cars with broken or missing couplers or couplers out of place. The owner maintained that had this car been properly inspected, the handling line would not have attempted to handle a cut of cars with a defective drawbar on the car next to the locomotive. The handling line's version of the situation was that the damage was caused by a coupler on another car dropping down. The damaged car was not being handled with a defective coupler as this defect originated in switching. It contended that the car owner was responsible as the car was not subjected to any of the unfair conditions specified in Rule 32.

In rendering its decision, the Arbitration Committee stated that Case No. 1231 is parallel and the same decision applies. This decision reads as follows: "The accident was caused by a collison when six cars broke away as the engineman applied the brakes while backing on the siding, making the damages the delivery line responsibility.—*Case No.* 1358, *Indiana Harbor Belt vs. Missouri-Kansas-Texas.*

Responsibility for car damaged in back-up movement

On March 27, 1924, a Gulf Coast Line train of 101 cars was backed onto a track to do some switching work, during which movement the conductor pulled the air from the caboose to make a stop and in doing so broke in two S.F.R.D. car No. 9956 and knocked G.C.L. caboose off center. The G.C.L. furnished an inspection report of S.F.R.D. car No. 9956, advised that it would cost $1,910 to repair the car and requested disposition under A.R.A. Rule 120. The handling line claimed, that as the train was backing up, the caboose was the head end of the train and that it was proper to apply the air from the caboose; therefore, the car owner was responsible for the damage under such conditions. The handling line stated further that the car was not subjected to any unfair usage and, therefore, Paragraph 5, Rule 32, did not apply in this case. The Atchison, Topeka & Santa Fe claimed that regardless of the direction in which the train was moving, the locomotive was the head end and that the damage caused by setting the air brakes at the caboose end was done from the "rear end" and is chargable to the handling line. The car owner contended further that the car was damaged by unfair usage in accordance with Interpretation No. 5 of A.R.A. Rule 32, which states in part "However, emergency application through manipulation from rear of train is unfair usage."

The Arbitration Committee rendered the following decision: "The caboose in this case must be considered under Interpretation No. 5 to Rule 32 as the rear end of train. The handling line is responsible."—*Case No.* 1359, *Gulf Coast Lines vs. Atchison, Topeka & Santa Fe.*

Industrial cars not equipped with quick-action triple valves

Ohio crane No. 1940, an industrial car traveling on its own wheels on revenue billing, as per note to Rule 3, page 17, of the 1923 Code of A. R. A. Rules, was received from the Norfolk & Western by the Caroline, Clinchfield & Ohio at St. Paul, Va., April 23, 1924, at which time the car was equipped with a 1¼-in. air brake pipe and angle cocks, an efficient hand brake, but no triple valve or reservoir. When the car was received at the Erwin, Tenn., shops of the C. C. & O., it was given the usual inspection and placed on the repair track to be equipped with power brakes. At the same time the repairing line requested the inspector at St. Paul, Va., to furnish an N. & W. defect card for the missing triple valve and reservoir, according to Rule 58. The N. & W. contended that a defect card was not due for these items on industrial cars traveling as per note to Rule 3, page 17 of the 1923 Code of A. R. A. Rules. The repairing line contended that the note to Interchange Rule 3 waives the provisions and requirements of Section (a), Rule 3, second paragraph only, insofar as it concerns cars of this class and that the note has no bearing on the first paragraph of Section (a), Rule 3, regarding any quick-action triple valve other than the A. R. A. standard type, and that a defect card for a missing triple valve and reservoir was due according to Rule 58. According to the specific wording of the rule and note in question, it was the further contention of the repairing line that cars of this class must be equipped with a quick action triple valve and that the note under A. R. A. Rule 3 on page 17 eliminates the requirement of the second paragraph of Section (a), Rule 3, that it is necessary that such cars be equipped with A. R. A. standard triple valve even though the car was built after January 1, 1919. Confusion regarding the acceptance of industrial or export cars shipped in accordance with Rule 3 arises from the failure to definitely determine the difference between any quick-action triple valve and the A. R. A. standard triple valve. The definite wording of the rule and the note in question makes it evident that an industrial car built after January 1, 1919, may be accepted in interchange without a K type, A. R. A. standard triple valve, but must be equipped with some type of quick-action triple.

The Arbitration Committee rendered the following decision: "The C. C. & O. was not required to accept the car in interchange. There is no rule requiring the delivery line to issue a defect card in a case of this kind. Therefore, the claim against the N. & W. for a defect card is not sustained."—*Case No.* 1357, *Carolina, Clinchfield & Ohio vs. Norfolk & Western.*

Setting valves of three-cylinder locomotives

By Jack Britton

Formerly Master Mechanic, Canadian National, Montreal, Que.

THREE-CYLINDER locomotives usually have two outside cylinders arranged in the same manner as for two-cylinder engines; the third cylinder, however, being located between the main frames underneath the smokebox or front end of the boiler. A crank axle is used when building up the driving wheels to which the main rod of the third or inside cylinder is connected.

H. N. Gresley, Chief Mechanical Engineer, London & North Eastern, invented a system of levers, etc., whereby the valve for the inside cylinder of a three cylinder locomotive derives its motion from the movements of the valves of the two outside cylinders. Fig. 1 shows a plan view of the assembly; Fig. 2 shows the arrangement of the three cylinders and a front view of the levers. The middle cylinder with its guide and crosshead is located on an incline and the main rod of the middle cylinder is connected to the second pair of driving wheels.

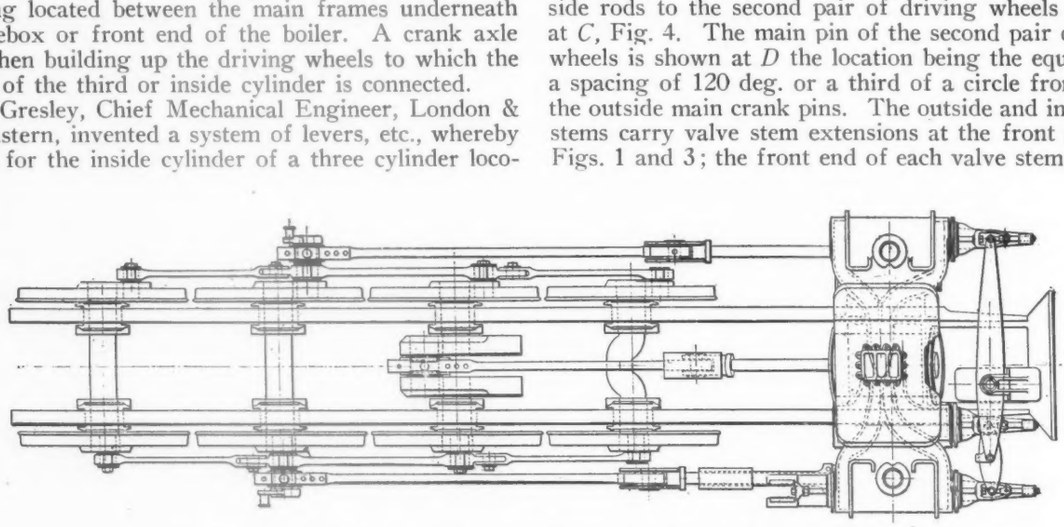


Fig. 1—Plan view of the valve mechanism of a three-cylinder locomotive

The outside valve gears are of the usual design applied to two-cylinder locomotives and all adjustments are made in the same way as for two-cylinder locomotives. Fig. 3 shows the outside main rods as they are connected to the third or main pair of driving wheels. The right main pin of the main driving wheels, shown at *A*, Fig. 4, leads the left main pin *B* by 120 deg. or a third of a circle in the forward gear. The main driving wheels are connected by side rods to the second pair of driving wheels as shown at *C*, Fig. 4. The main pin of the second pair of driving wheels is shown at *D* the location being the equivalent of a spacing of 120 deg. or a third of a circle from each of the outside main crank pins. The outside and inside valve stems carry valve stem extensions at the front as seen in Figs. 1 and 3; the front end of each valve stem extension has a bearing support. The inside valve gear consists of two transverse levers located in front of the cylinders and connected to the valve stem extensions.

A line sketch of the levers and valve stem extensions is shown in Fig 5. The long lever is fulcrumed at *A*, the fulcrum bracket of which is rigidly fastened to the structure of the locomotive. A suitably arranged buckle, which forms part of the valve stem extension, is fitted to the front end of each valve stem as shown at *B*, Fig. 5. A short link connects each valve stem extension with its respective lever as shown at *C*. The middle point of the short lever is pivoted to the end of the short arm of the

long lever as shown at *D*. The ends of the short lever are connected by the links to the extensions of the right and the inside valve stems as at *E* and *F*, Fig. 5.

With the exception of a small allowance to compensate for lost motion, the long arm *G* of the long lever is twice as long as the short arm *H* of the long lever. Except for a similar allowance for lost motion, the arms *J* and *K* of the short lever are equal in length.

As the outer end of the short lever is driven by the right-hand valve gear, its inner end has a similar but opposite motion except as it is modified by the movement of its pivot point *D* which receives its motion from the left hand valve gear. The resultant motion is similar to that of the outside valves and so timed that with the right and left cylinders connected 120 deg. apart, the motion of the inside valve will be correct for the middle cylinder 120 deg. from the right and left cylinders.

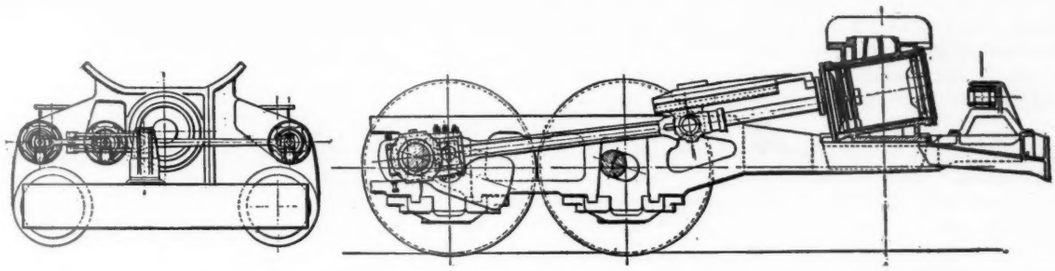


Fig. 2—At the left is a front view of the valve lever arrangement and at the right is the inclined middle cylinder with its guide and crosshead

Valve setting details

The right and left valve gears are adjusted in the same manner as for two-cylinder locomotives and should be completed, with all the necessary changes actually made and the gears reassembled before checking the motion of the inside valve.

In order to adjust the inside valve gear, it is only necessary to apply washers of the proper thickness on the valve stems where they fit into the valve stem extensions which squares the valve events at the running cut-off of say 33 per cent forward motion. When applying thicker or thinner washers to the valve stem extensions, it must be remembered that the inside valve will be moved the amount of the change in the thickness of the washer, regardless of whether the change is made at the inside stem or at one of the outside stem extensions; that is, a 1/16-in. change at either stem will move the inside valve 1/16 in., or if the washers are changed at more than one valve stem extension, the inside valve will be moved the sum of the changes in the washer thicknesses.

The following example is chosen for a clear understanding. Let it be assumed that the three valve gears are properly adjusted. Let the washer *A*, Fig. 6, at the right valve stem extension be replaced by another washer ⅛ in. thicker. Since the lengths of the arms *J* and *K*, Fig. 5, of the short lever are equal and are pivoted as at *D*, Fig. 5, the inside valve will be moved back ⅛-in., as shown at *B*, Fig. 6. Again, let the washer at the left valve stem extension *C*, Fig. 6, be replaced by another washer ⅛ in. thicker. Since the long arm *G*, Fig. 5, is twice as long as the short arm *H*, Fig. 5, the pivotal point *D*, Fig. 6, will be moved backwards 1/16 in. by the second change. Owing to the right valve stem and its extension remaining stationary with regard to the second change and the point *D* being moved backwards 1/6 in., the short lever is the means whereby the middle valve is moved backwards ⅛ in. by the second change as shown at *F*, Fig. 6. In order for the inside valve stem to be re-adjusted in length to square the valve events the same as before, the washer thickness changes are made to the front ends of the outside valve stems. It is necessary to reduce the thickness of the washer at *E*, Fig. 6, ¼ in.; that is, an amount equal to the sum of the changes in the thicknesses of the two outside valve stem extension washers.

The inside valve events are affected when the following changes are made:

First—If a length change is made to an eccentric rod or valve rod on an outside valve gear, the valve events on that side are affected as well as the inside valve events. If a length change is made to either eccentric rod or a valve rod, or a change is made in the thickness of a valve stem extension washer on both outside valve gears, the effect on the inside valve events is equal to the sum of the effects caused by the changes made on both the outside valve gears.

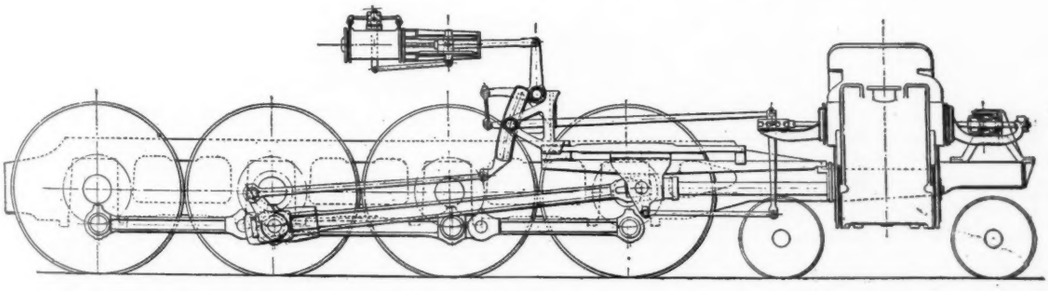


Fig. 3—The outside main rods of a three-cylinder locomotive, connected to the third pair or main driving wheels

Second—If only a valve stem washer (not a valve stem extension washer) thickness is changed to square the events of an outside valve, the inside valve events are not affected provided that the valve stem extension on that side is replaced in the same manner as before the change was made.

Third—If an outside valve stem extension washer

thickness is changed, the outside valve events on that side are not affected but the inside valve events are affected.

Fourth—If the inside valve stem extension washer thickness is changed, the inside valve events are affected, but the outside valve events are not affected.

Port marks and valve stem expansion allowances

When setting the valves on a cold engine, whether fitted with a superheater or not, due regard for the expansion of the various parts when the engine is working under steam must be considered. When taking port marks on the valve stems, or brackets if used, of a three-cylinder locomotive equipped with the Gresley levers, make the same allowance for expansion if inside admission valves are used on the outside cylinders. When taking the port marks on the valve stem, or brackets if used, of the inside cylinder, make an allowance of 3/64-in. in a case where inside admission valves are used and 5/64-in. if outside admission valves are used, but in both cases instead of center popping the port marks ahead, center pop them behind.

There may be a slight variation on some locomotives from this procedure of obtaining the port marks mentioned, but not enough to affect seriously the valve events. Checking up on one locomotive of each class will determine this.

When a valve stem tram is used to scribe the lines necessary to obtain the port marks and the scribed lines, the straight line on the three valve stems respectively shown in Fig. 7 is marked at *A* and *B*. The center *C* is then found in each case. If inside admission valves are used, it is to be noted that the center from which to lay off the port marks for valve setting purposes is marked off for the right and left valves, 1/32 in. ahead as shown at *D*, Fig. 7, and for the middle valve 3/64 in. behind as shown at *E*, Fig. 7.

If outside admission valves are used on all three cylinders, then in the case of the right and left valves, no allowance is made and the center *C* is the center of the port marks *A* and *B*, Fig. 8, which are to be used for valve setting purposes. The center *E*, Fig. 8, from which to lay off the port marks for the middle valve is center popped 5/64 in. behind the center of the points *A* and *B*.

The reason for the above procedure may be followed

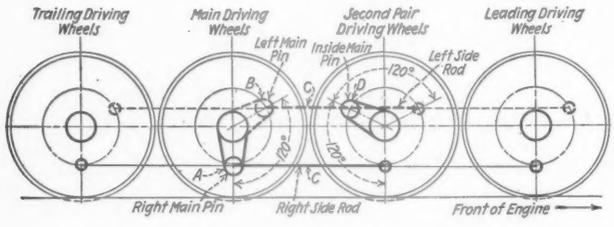


Fig. 4

step by step, using a superheater locomotive as an example.

First—The 1/32-in. allowance ahead when taking the port marks on the outside valve stems when inside admission valves are used, allows for the slight difference in the expansions between the valve stem and the cylinder which occurs behind the center line of the valve seat or valve chamber, also to compensate more or less for the mean volume occupied by the piston rod, at the various cut-offs. Certain tests made on superheater engines with various temperatures in the steam chests, proved this allowance to be suitable for the majority of locomotives. In the case of outside admission valves, no allowance is made because the difference in the expansions between the valve stems and cylinder behind the center of the valve seat is compensated by the mean volume of the piston rod when the variable out-offs are considered.

Second—In the case of three-cylinder locomotives where the Gresley system of levers and valve stem extensions are used, the extra length of the valve stem on the front end affected by the superheated steam increases the difference in the expansions between the valve stems and the cylinders. This occurs on both outside valve stems and both have an equal effect, the sum of which is reflected on the middle valve events. This is common to all three-cylinder locomotives no matter whether inside or outside admission valves are used.

Third—The difference in the expansions between the

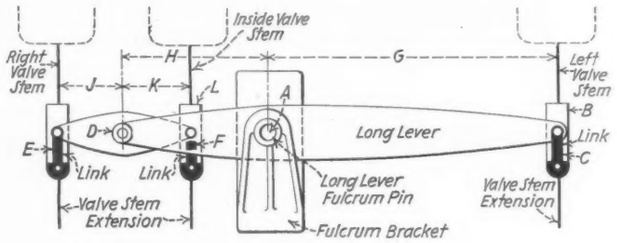


Fig. 5—Front levers and valve stem extensions

middle valve stem and the cylinder in front of the center line of the valve seat or valve chamber and the allowance for the mean volume of the piston rod of the inside engine must be considered.

Fourth—The frame splices expand with the cylinders and carry the long lever fulcrum bracket ahead, which, however, does not affect the valve events on the middle cylinder in any other way than that mentioned in the three previous items.

Where an allowance of 1/32 in. is made when taking port marks for the outside cylinders where *inside admission* valves are used, and no allowance is made where *outside admission* valves are used as explained in item 1, it is to be noted that the amount of the valve stem effective expansion, which has a bearing on the valve movements of the *outside* cylinders, occurs at the *back* of the valve.

The amount of valve stem effective expansion, which has a bearing on the valve events of the *middle* cylinder, occurs at the *front* of the valve. It is to be noted, when taking port marks for the valve of the middle cylinder in the case of outside admission valves as compared with inside admission valves, that the allowance to be made is greater for an outside admission valve than for an inside admission valve.

It might be added at this time that when the boiler as well as other expansion effects on valve movements are properly understood, greater confidence will be established and definite methods may be more closely followed.

Motion fitting—In the case of a three-cylinder locomotive, the same particular care must be exercised in checking the accuracy of the dimensions, the relative location of the parts, the removal of all unnecessary sets and twists from the various parts and the ensuring of freedom of movement of the parts separately and collectively during the assembly which precedes valve setting operations as is taken when setting the valves on a two-cylinder locomotive.

Bump marks and crosshead travel—The method of determining valve bump marks, piston bump marks, and main crosshead travels is the same as the method used for the Stevenson gear.

Dead centers—On two-cylinder locomotives the cylinder center line is usually 2½ in. or 3 in. above a straight

line which corresponds with the level of the driving wheel centers. Owing to this fact, the angle of a main rod is slightly different when the main pin is on its back dead center as compared with when it is on its front dead center as is shown at *A* and *B*, Fig. 9, which are exaggerated angles for the sake of clearness. This means that the front and back dead centers when found on the driving wheel are less than 180 deg. apart when measured one way and more than 180 deg. apart when measured the other way as is shown in Fig. 10.

In the case of the three-cylinder locomotive the four dead centers for the outside cylinders only are found on

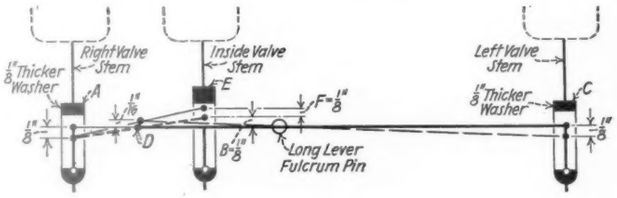


Fig. 6

the right main driving wheel in a manner similar to locating them on two cylinder locomotives. The two dead centers for the inside cylinder are not required for the following reason. The designer lays out the inside valve gear in a way that will insure good steam distribution when the outside valve gears are set correctly and the inside valve gear adjustments are made after the outside valve gear adjustments are actually completed.

Long valve travel—When the main pin of either the right or left inside cylinder is placed on a top or bottom working quarter, with the reverse gear in mid-position, the valve of the engine spotted on the quarter will be placed approximately on the center of its seat so as to cover both steam ports. By moving the reverse gear from one full gear position to the other, the valve will be moved through its long valve travel.

Short valve travel—By revolving the locomotive with the reverse gear in its mid-position, the valves of the three

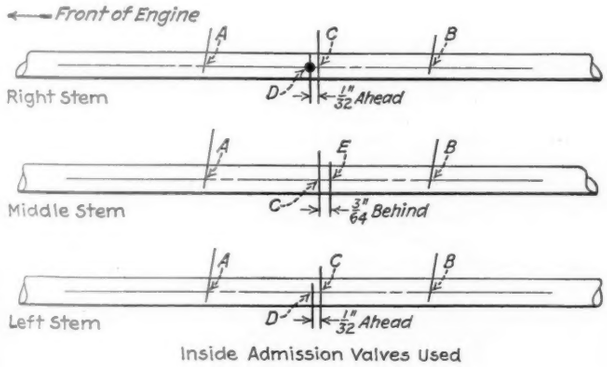


Fig. 7

cylinders will move through the lap and lead travel or the short travel of the valve.

Cut-offs—If the cut-offs are required for the inside cylinder, rollers must be used under the second pair of driving wheels as well as under the main driving wheels with the side rods connecting these drivers.

Important points to remember when setting the valves

The valves of the outside cylinders are set in the same manner as for two-cylinder locomotives dependent on the valve gear used. The setting of the valves on the two outside cylinders must be completed and the changes actually made before taking a valve reading to determine the adjustment required for the inside valve gear.

When taking port marks on a cold engine for valve setting purposes, due allowance should be made for valve stem expansion effects and piston rod volumes where necessary, on the inside as well as on the outside valve stems or brackets, if used. It should be thoroughly understood in what way the middle valve is affected by changes made to the outside valve gears or to the thickness of the valve stem extension washers. If any change is made in the adjustment of the outside valve gears, the inside or middle valve position must be rechecked.

After all valve setting adjustments have actually been made and valve motion report details taken if required, the main reach rod may be lengthened sufficiently to counteract boiler expansion effects, if any, on the valve gears.

When setting the outside Walschaert valve gears, the standard practice should be followed, except for the final lengthening of the main reach rod to counteract the boiler

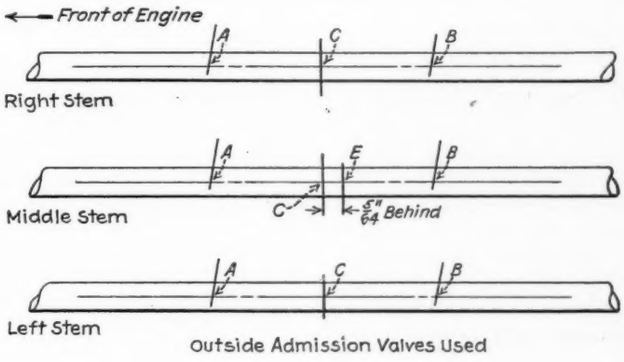


Fig. 8

expansion effect on the valve gears; this operation is performed later. When the outside valve gears are properly set, with all the changes made and the parts reassembled, the rollers are left under the main drivers for use in setting the inside valve gear. Assemble the parts of the inside valve gear, checking the dimensions of the parts, including the valve stem extensions and the relative location of the long lever fulcrum pin and bracket.

Remove unnecessary rod sets and twists and try all parts for freedom of movement while assembling them. Place the reverse gear in the full gear forward position, roll the main drivers ahead until the outside valve stems move, then continue until, for instance, the right main crosshead reaches one-third of its stroke after leaving the front crosshead travel mark, then stop. Suppose the stroke of the right main pin is 30 in., then stop when the crosshead has moved 10 in. from the commencement of its travel. Hook up the reverse gear toward its mid position until the port mark of the right front forward cut-off arrives exactly underneath the valve stem tram point, when held in the same position as when taking port marks on the right side, then stop.

Drop the reverse lever catch into the nearest slot in the quadrant or otherwise secure the reverse gear in this position. With the reverse gear in this 33 per cent running cut-off position, roll the main drivers forward until the front and back inside valve travel lines are scribed on the inside valve stem or bracket if used.

Find the center of these valve travel lines with a pair of dividers and if it coincides with the center of the port

marks, the inside valve events will be correct. If these points do not coincide and say, for instance, the center of the port marks is 1/16 in. behind the center of the valve travel lines, the inside valve stem extension washer must be reduced in thickness 1/16 in.; that is, the amount of change to be made in the thickness of the middle valve stem extension washer is determined by measuring the exact distance between the center of the port marks and the center of the valve travel lines.

Whether to increase or decrease the thickness of the middle valve stem extension washer is determined by moving the center of the port marks towards the center of the

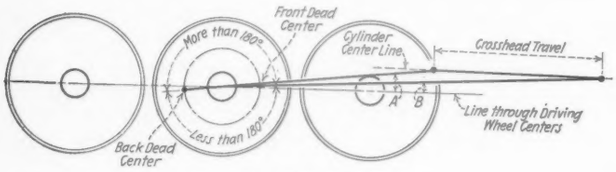


Fig. 9

valve travel lines and changing the thickness of the washer accordingly. Make the actual change required, if any, to the thickness of the middle valve stem extension washer. Place the reverse gear in the full gear forward and full gear back positions respectively and scribe the inside full gear valve travels.

With due regard to the full gear valve travels on all three cylinders and the respective valve bump marks as well as the specified full gear valve travels, adjust the reverse gear stop pins. Finally lengthen the main reach rod to counteract the boiler expansion effect on the valve gears, if any.

When the engine is first moved slowly on the outgoing track, the main crosshead travels of the middle cylinder must be scribed and the inside main rod properly adjusted for length accordingly.

Flexible pipe for locomotive blow back operation

IMPROVEMENTS have recently been made in the Cumberland, Md., shops of the Baltimore & Ohio, in the operation of locomotive boiler washing, by providing a better method for the coupling up or connecting

How the apparatus is used

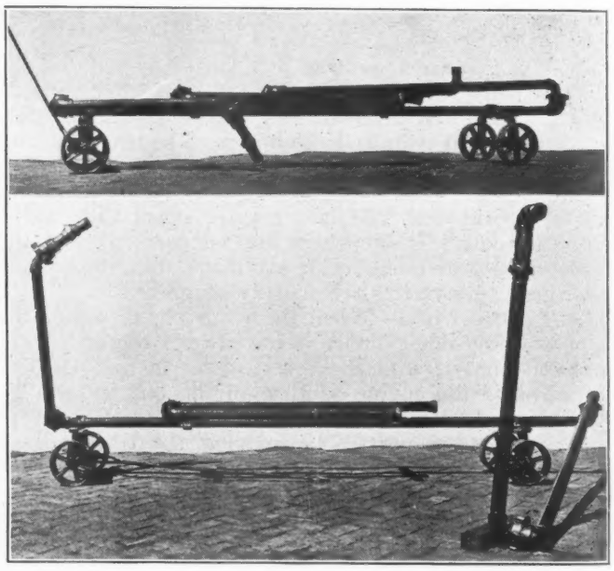
of the boiler with the enginehouse piping system, for the blow back operation.

In the past, hose of various makes, types and construction had been used for this operation. Since hot water and steam at high temperature and pressure pass through this apparatus, the management provided the best and most reliable hose obtainable, such as a specially constructed armor-covered hose.

This hose is safe, but not sufficiently durable, for under the most favorable conditions the inside fabric soon deteriorates and collapses under the hot water and steam and the outer metallic armor construction is also of short life, for in a busy shop many things happen that tend to nick, dent, crush and finally cause the armor to collapse. While not of frequent occurrence, cases have been known of hose being cut in two by being run over by the wheels of a locomotive. These special hose are costly, averaging $55.50 each and the average life is 33 days and, as they are especially fitted up by the manufacturer, when any part is injured they are practically unreclaimable locally.

Further, in the handling and transporting of the hose from one point of operation to another, it requires the services of two men, as they are too heavy and cumbersome for one man to handle.

To provide a better, safer and a more economical means



The upper view shows the apparatus folded and ready to be wheeled where needed, while the lower view shows the device extended and in shape to be attached to a boiler and enginehouse piping system

of carrying out this operation, a method has been designed, as shown in the accompanying illustration, by Master Mechanic F. W. Fritchey and developed by C. M. Kennedy, pipefitter foreman, of the Cumberland shops. This device has been in service for over two months and is giving excellent results.

It will be observed that it is constructed of a system of piping and metallic flexible joints and is mounted on a set of four small wheels. It is easily handled, transported and coupled—in fact, all operations are performed by one man. It is practically indestructible and if any part should be damaged, it can be repaired or reclaimed locally. The initial cost of this device was $64.94, which includes labor and material.

The description of this device was secured through the courtesy of the Baltimore and Ohio magazine.

FOOTBOARD AT REAR OF SHIFTING ENGINE NOT REQUIRED.—The Circuit Court of Appeals, First Circuit, holds that neither the Safety Appliance Act, nor I. C. C. regulations require a footboard at the rear end of the tender of a shifting engine. The commission has only prescribed how, if one is used there, it shall be constructed and applied.—C. V. v. Perry, 10 F. (2d), 132.

Co-ordinated production control

Its functions and accomplishments in the North Little Rock Shops of the Missouri Pacific

THE practical application of an up-to-date schedule and shop production plan which has been "sold" to the entire supervision and forces of the Missouri Pacific 24 pit locomotive shops at Little Rock, Ark., has resulted in a marked increase in locomotive output and reduced unit costs during the past few months. A comparison of the shop output in 1924 and 1925 is shown in Table I while Table II indicates the generally heavier character of the work. There was essentially no change in the number of men employed, the division between the various crafts being shown in Table III.

In compiling the record of schedule or shopping days in Table IV Sundays and holidays are not included. The report shows a reduction in shopping days during the past nine months of 10½ days per locomotive. During July, 1925, the monthly progress report revealed 155 delay days charged against the erecting floor; the February, 1926, report showed this condition reduced to 8½ delay days. The average number of engines turned out per month in 1924 was 13 3/10; in 1925, 14 5/10; to date, 16. The scheduling system has been extended to the passenger and freight car department.

Any new system is an innovation for only a short time. As it continues, if practical and clearly understood by all, it speeds up and runs more freely like a locomotive properly "broken in." The requisites of the successful scheduling and production control plan as installed at the North Little Rock shops of the Missouri Pacific are:

A—Adequate advice regarding repairs needed in advance of the dates of shopping of engines.

B—A property co-ordinated method of routing work from stripping to erecting.

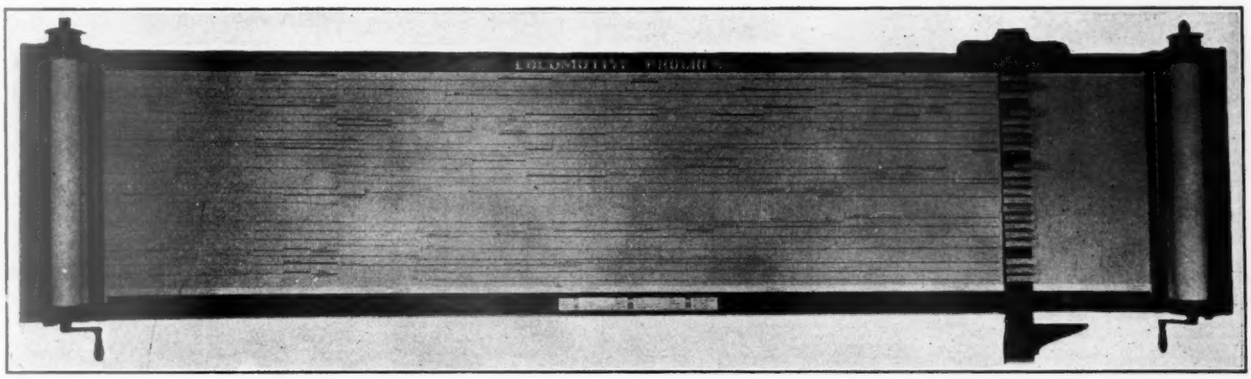
C—Hearty co-operation of officers and workmen.

D—Full co-operation of the purchasing and stores department.

A proper scheduling and routing method is comparable with the recording gages of a power plant, furnishing prompt information of delays, congestion or lowered production in time to correct the trouble without loss of output. Through a properly organized scheduling and routing plan, the officers are constantly in control of the shops. They have immediate information, in detail, of all the factors which enable them to make prompt and correct decisions.

Co-operation of shop foremen must be secured

Since the co-operation of the supervisory officers is absolutely necessary, they must be convinced that the principles of the plan are right, that their authority is not invaded and that they themselves are really running the plans in their individual shops.



Locomotive progress chart visualizing conditions of material, sequence of operation and causes of delay. The T-square shows engine numbers, date in shop, class of repairs and completion date

Table I—Comparative shop output of locomotives, 1924-25

	Output for 1924	Output for 1925
Class 1 repairs	8	25
Class 2 repairs	4	50
Class 3 repairs	112	98
Total	160	173

The success of the functioning of the production department in the North Little Rock shops is directly attributed to the complete co-operation constantly evident between everyone concerned. Some of the practical advantages of the method of co-ordinated production control used at Little Rock are as follows:

1—The history of each locomotive is chartered and its performance carefully recorded. The value of this is inestimable.

2—Repairs are planned in advance, thus preventing delays in procurement of and shortage of material inasmuch as early advice to the stores department before

Table II—Generally heavier work was handled in 1925

	1924	1925
New boilers	6	19
New fireboxes	35	42
New cylinders	34 pairs	36
New cylinders	21 single	11
New valve gear	8	11
Superheaters	5	5
Syphons	14	68
Tank frames	41	37
Tank cisterns	14	16
Flue sheets	42	33
Reverse gear	16	20
Oil burners	6	17
Steel cabs	4	25

shopping of either engines or cars indicate the major items needed.

3—It encourages supervisory forces to think in dollars and cents, as well as in units of output.

4—By means of an efficient stores system and stores accounting and operating system it reduces inventories to a minimum and prevents the building up of obsolete stock.

5—The setting of time for the completion of each job serves as a goal which, when fairly established, considerably expedites production.

6—The maintaining of a master chart and divisional charts shows the progress made on every locomotive

Table III—Average force of mechanics in locomotive department, 1925

Machinists	211
Boilermakers	66
Blacksmiths	29
Pipe fitters	31
Electricians	18
Loco. carpenters	14
Total	369

Note—Of this force of mechanics 77 were engaged exclusively on machine work for North Little Rock Round House engines and handling machine work on material for outside points.

repair job each day and serves to show where there is failure to meet schedule.

7—The daily follow-up uncovers delays at once and makes possible immediate corrective measures.

8—Delays in the re-assembling of equipment are prevented. Work that should be done is not sidetracked.

9—Proper routing prepares the way for operations as completed by the previous group of workmen. The time

Form 7076 SM—11-25

MISSOURI PACIFIC RAILROAD COMPANY

Mechanical Department

MATERIAL MOVE ORDER

Date_____ Engine No._____ Group No._____

From_____ Shops To_____ Shops

QUANTITY	DESCRIPTION OF MATERIAL

Material received by_____ Foreman_____ Dept.

Immediately upon completion of this work, return this order to Production Department.

This form filled out and placed on hook at "material move" foreman's desk assures movement of finished material to its destination within 15 min.

lost between jobs is reduced to a minimum and material and parts necessary for repairs are on hand in proper sequence.

Plans started with receipt of work report

The production department of the North Little Rock back shops consists of a production engineer, scheduling supervisor, material supervisor and material clerk.

The first functioning of the production department in connection with the shopping of a locomotive begins with the receipt by the mechanical department of the master mechanic's work report, outlining the class of repairs to be extended, description of the work, whether parts are to be renewed or repaired and their pattern number. This locomotive work report is compiled by the mechanical inspector while inspecting the locomotive during the course of the stripping operation, which usually requires from 12 to 24 hours with an organized stripping gang, under the supervision of a lead man.

Copies of the locomotive work report are forwarded to the shop superintendent, the supply department and the production department. The copy to the supply de-

Table IV—Scheduled and actual shopping days for a nine Months' Period

	Scheduled shopping days	Actual shopping days
July, 1925	41	46-1/2
July, 1925	41	46-1/2
August	44	44
September	43	45
October	40	44-4/5
November	34	42-1/5
December	33-7/10	41
January, 1926	30-2/10	35-5/10
February, 1926	36-6/10	38-4/10
March, 1926	32	35

partment serves as advance information regarding parts needed for repairs and is checked against its stock records. This record is maintained in the supply department through the operation of a control board, giving the

North Little Rock, Ark., May, 12, 1926.

In shop 10-7 Engine No. 79 Scheduled 10-13

Due for service 10-31 Class repairs # 3 Pit 6

Shopping days -- 22

Front end and netting removed	10-7
Brake riggin and binders removed	10-7
Engine dewheeled	10-8
Spring riggin removed	10-8
Cab and running boards removed	10-8
Jacket and laggin removed	10-9
Motion work stripped	10-9
Pistons and crossheads removed	10-9
Stripping complete	10-10
Flues removed	10-10
Parts dispatched	10-10
Binders returned from Bkls, shop	10-14
Shoes and wedges machined	10-14
Furnace bearer machined	10-15
Guides machined	10-15
Shoes and wedges applied to frames	10-16
Driving boxes planed	10-17
Spring riggin returned from Bkls, shop	10-17
Furnace bearer applied	10-19
Shoes and wedges laid off	10-20
Brass work and boiler fixtures applied	10-21
BOILER TEST	10-22
Tank frame and trucks complete	10-22
Spring riggin machined	10-22
Air pumps and reservoirs applied	10-23
Laggin applied	10-23
Brake riggin returned from Bkls, shop	10-23
Engine wheeled and trammed	10-23
Motion work delivered from link gang	10-23
Tank tested and moved to paint shop	10-23
Motion work applied	10-24
Cab and running boards applied	10-24
Jacket applied	10-24
Guides lined	10-24
Piston and crossheads applied	10-26
Steam pipes tested	10-26
Valves set	10-27
Main and side rods applied	10-28
Tank complete	10-28
Brake riggin applied	10-28
Ash pan, Grates and front end complete	10-28
Air pipes and equipment OK	10-28
Out Shop, Air tested, Pops set	10-29
On trial	10-30
OK for service	10-31

PRODUCTION DEPARTMENT

Typical master sheet

"in shop" date of the locomotive, the date the material will be required and the date the engine is scheduled for delivery to the transportation department. This information is maintained by a material clerk who, by means of various colored tags, keeps track of the exact condition of the material. A blue tag, for example, denotes material condition being checked, a red tag that the material is ordered and a white tag that the material has been received and delivered to the shop.

All requisitions for material originate with the gang

foreman directly responsible for the repairs on a locomotive assigned to his gang. They are then forwarded to the production department which checks for correct charges and scrap credit; and are then turned over to the "material move" gang foreman, in charge of delivery of all material. A force of eight men equipped with two power trucks and necessary trailers are employed in moving material. Material move orders are picked up every 15 min.

Information regarding new parts required is compiled when an engine is stripped. All parts, as removed, are delivered to the cleaning vats on schedule and, after being cleaned, are inspected to determine their fitness for use again, which determines the new material required.

Boiler test date the controlling factor

Immediately after the stripping operation is completed, the scheduling supervisor, through constant contact with the shop supervisors compiles a complete schedule for each locomotive, centering this activity around the boiler test date, the controlling factor.

The schedule contains the major operations and their completion date, which information is delivered in duplicate copies of the schedule to each supervisor concerned. The average number of schedule days on this property, embracing Classes 1, 2 and 3 repairs, is based on an average of 30 shopping days from the date the engine is delivered on the pits until it is O. K. for service.

Co-ordinated with the functioning of the schedule is the important factor of production control boards and the locomotive progress chart. Production control boards, installed in each department give the "in shop" date of the locomotive, the schedule completion date of the operation concerning individual departments, the boiler test date and the scheduled date of completion. These production control boards, maintained by foremen for their individual information visualize at all times the condition of locomotives under their charge.

Schedule is flexible and accurate

The schedule is, however, flexible enough to take care of minor work not in the original calculations which develops during repairs. Care is taken to have all information contained upon the schedule and production boards strictly accurate so as to make possible complete co-operation between the shop supervisory forces and the production department and create confidence in the production plan.

The continued existence of hearty co-operation in the North Little Rock back shops is responsible for a 22 per cent reduction in shopping time on locomotives in the past 12 months and this reduction in shopping days pertains only to Class 1, 2 and 3 repairs with practically the same force. The classification of repairs on the Missouri Pacific is as follows:

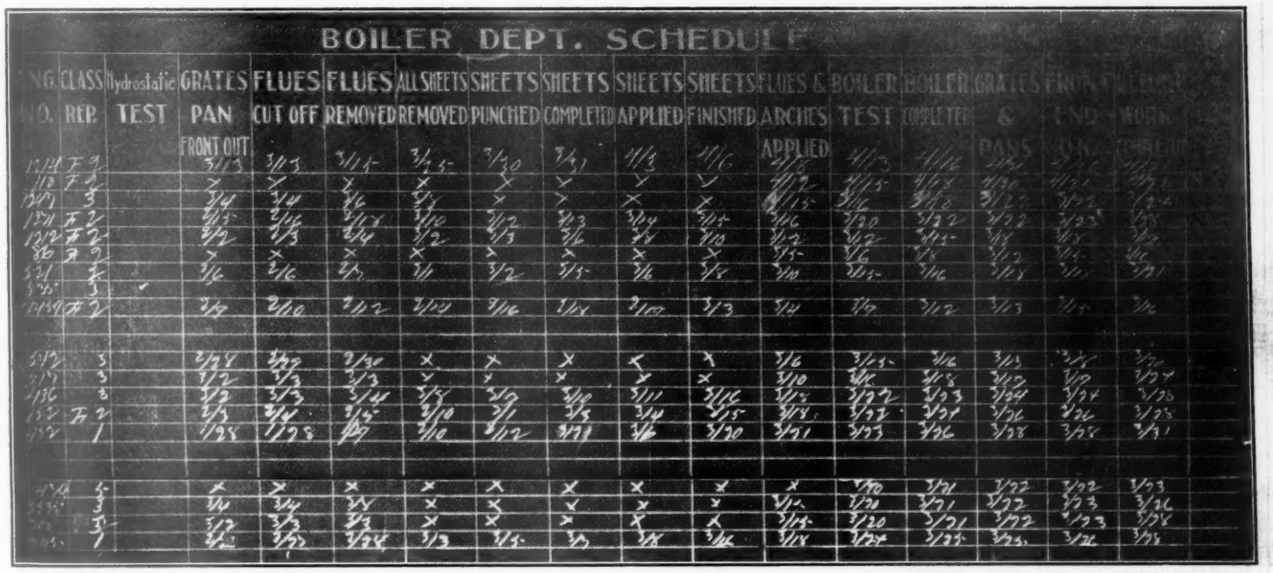
Class 1—New boiler or new back end. Flues new or reset. Tires turned or new. General repairs to machinery and tender.

Class 2—New firebox, or one or more shell courses, or roof sheet. Flues new or reset. Tires turned or new. General repairs to machinery and tender.

Class 3—Flues all new or reset (superheater flues may be excepted). Necessary repairs to firebox and boiler. Tires turned or new. General repairs to machinery and tender.

Class 4—Flues part or full set. Light repairs to boiler or firebox. Tires turned or new. Necessary repairs to machinery and tender.

Class 5—Tires turned or new. Necessary repairs to boiler, machinery and tender, including one or more pairs of driving wheel bearings refitted.



Typical department schedule board showing the dates due

General repairs to machinery include driving wheels removed, tires turned or changed, journals turned if necessary, and all driving boxes and rods overhauled, and bearings refitted, and other repairs necessary for a full term of service.

The suffix A after the class designation indicates accident repairs; B indicates new boiler; BE, a new back end, and F, a new fire box.

Master progress chart of new design

To visualize the daily condition of locomotives and the progress of repairs, a master locomotive progress chart is maintained in the production office, in the shop superintendent's office, and in the office of the chief mechanical officer of the system. This chart is so constructed that it operates on rollers, carrying a continuous roll of drawing paper 20 in. wide and 50 yards in length, which permits the carrying of a two years' reference record of performance of locomotives, visualizing complete data, such as date in shop, scheduled date due for service, actual date of delivery to the transportation department and the shop department responsible for any delays incurred during the shopping period.

When an engine is brought into the shop, it is entered

on the master chart under the date which is on the top of the chart. This entry is made in blue—denoting normal progress. In order to visualize completely any department responsible for delay, each department in the shop is given a distinctive color, and the departments are divided as follows:

Air department	light blue
Erecting floor	sepia brown
Tank shop	dark brown
Link and motion department	olive green
Engineering department	dark green
Blacksmith shop	purple
Machine shop	black
Stores department	red
Pipe department	orange
Boiler shop	yellow
Crane and trucking department	gray
Miscellaneous	pink
Superintendent's office	dark blue—interrupted line

As the engine progresses from day to day in the course of its repairs, the line is carried horizontally

Engine No. 79 — MISSOURI PACIFIC RAILWAY COMPANY — Date in Shop 10-1
Class Repairs 3 — Mechanical Department — Date out Shop 10-31
Shopping days 22

LOCOMOTIVE WORK REPORT

North Little Rock Shop — Date in Production Dept.

DESCRIPTION	New.	Repd.	Patt. No.
Stack		X	7140
Stack base		X	7142
Stack extension			
Front door ring	Pressed steel		"16"
Door ring liner			
Front end door			
Flag brackets	2		M-521
Peep hole (lid and base)			
Smoke arch braces			
Sand box			
Sand traps			
Dome cap			
Dome casing		(	12-X-3661
Hand rail columns	16	(	3-X-4282
Grab irons			
Headlight bracket	1		X-2358
Bell			
Bell crank			
Bell yoke			
Bell frame			
Number plate			
Hand rail tops	16	X	3668
CYLINDERS, ETC.			
Cylinders	2V 24x30x65		
Cylinder bushing			
Cylinder bore			
Splice bolts			
Frame bolts and keys			
Heads (front)			
Heads (back)			
Casings (front)	2	X	4545
Casings (back)	1	X	4546
Cylinder jacket			
Cylinder cocks	4	X	3154
Guide yoke			
Guide yoke ends			
Guide yoke brackets			
Guide bars			
Guide blocks			
Guide cups	2		
Valve chambers			
Valve bushings			
Heads (front)			
Heads (back)			
Casings (front)			
Casings (back)			
Valve seats			
Steam chests			

DESCRIPTION	New.	Repd.	Patt. No.
Cylinders—Continued.			
Steam chest covers			
Pressure plates			
Cover casing			
Steam chest casing			
Tumbling shaft			
Tumbling shaft boxes			
Counterbalance			
DRIVING GEAR			
Driving tires	Turn		
Driver retaining rings			
Trailer tires			
Trailer retaining rings			
Dr. wheel centers			
Tr. wheel centers			
Front axle	1	#	8
Back "	1	#	8
CRANK PINS			
Crank (F)	2	#	25
Crank pins (F. Int.)			
Crank pins (M)	2	#	33
Crank pins (B. Int.)			
Crank pins (B)			
Rub. liners	8	#	4749
LINK AND MOTION			
Piston heads	2	X	7122
Piston Bull rings			
Packing rings	6		
Piston rods			
Piston glands			
Crossheads	2	S	489
Crosshead shoes	4	O	2475
Crosshead pins			
Valves			
Valve glands			
Valve rings and strips			
Bull rings			
Valve stems and yokes			
Valve stem guides			
Valve stem X-head			

Page 1 of a typical four-page locomotive work report

across the chart. Any delay occurring is charged to the department responsible, its representative color being inserted to replace the normal blue line—raised or lowered slightly from the direct horizontal to focus attention. For example, should the erecting floor fail to make the schedule date, the line is changed from blue to brown. The reason for the delay is specifically stated on the chart, affording a basis for immediate application of the remedy by the shop superintendent and general foreman.

Short schedules afford a mark at which to shoot

One fact in proof of the success of this visualization of conditions contributing to delays is the reduction by 85 per cent of delays in the erecting department alone in the past twelve months, brought about by the advanced information furnished the various supervisors and their response to this condition through complete co-operation.

Schedules as compiled are made somewhat short intentionally, with the idea of setting a mark to aim at, thus keeping the various departments keyed up to a point where the production will approach, as nearly as possible, the mark set as a schedule. If this mark could be constantly maintained without intensive effort, the incentive element would be lacking. The efforts displayed by the supervisors in endeavoring to maintain schedules as nearly as possible is very commendable to the shop organization as a whole.

Throughout the development of this particular plan, it has been constantly explained and interpreted to all affected that the plan is of mutual benefit to every one in the shop. This viewpoint has been accepted and furnishes a big reason for the full acceptance of the plan itself. Every objection to the inauguration of the plan has been met by the facts and sound interpretations thereof. The why of the plan has been clearly explained and the shop men shown the fairness of all changes.

Removable lateral liner for engine and trailer truck boxes

*By F. W. Lampton**
and W. B. Murney†

ONE of the items which help increase the maintenance costs of a locomotive is the keeping up of the lateral motion in the engine and trailing truck boxes. A removable lateral brass liner has been developed on the Frisco for use on Mountain type passenger locomotives. The comparative test of the removable liner against the poured brass liner over a 138-mile division with plenty

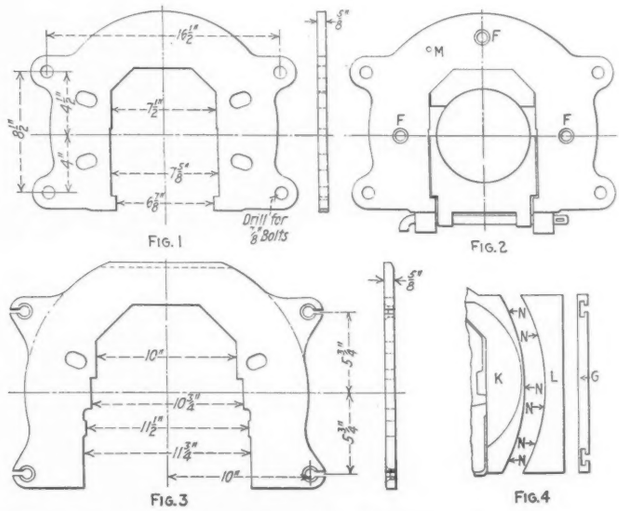


Fig. 1—Brass liner for engine truck boxes; Fig. 2—Method of applying steel liner to old engine truck boxes preparatory to the application of the brass liner; Fig. 3—Brass liner for trailer truck boxes; Fig. 4—Method of welding a new piece on old trailer truck boxes

of curves proved conclusively that the former outwore three sets of the latter.

It was found from experience that when the brass liner was poured on, it seemed to chill and would check out from the pins that were driven in the box to help hold the brass in place; also when the brass was poured into

* General enginehouse foreman, St. L.-S. F., Springfield, Mo.
† Traveling inspector, St. L. S. F., Springfield, Mo.

the dovetail part of the box, and then cooled off, it would shrink away from the box and become loose. By applying the liners as shown in the following illustration this trouble was eliminated.

Another point gained by this application is that once the engine truck boxes are equipped with the liners, the boxes never have to be removed to take up the lateral motion, as this can then be done by removing the worn out liner and applying a new liner by merely removing and replacing four 7/8-in. bolts.

In preparing an old engine truck box for the new liner, about 1/2-in. is faced off of the lateral side of the box. Then a liner, similar in contour to the brass liner shown in Fig. 1, is cut from 1/2-in. boiler plate. This plate is secured to the old engine truck box by three countersunk head bolts, 1 in. in diameter and 1 3/4 in. long, eight thread. The bolts are counter-sunk 1/16 in. under the surface of the liner and when tightened, the head is electric welded to the plate so it will not become loose or back out. The locations of these bolts is shown at F, F, F, Fig. 2.

The cast brass liner, as shown in Fig. 1, is now ready to be put in place. It is held by four 7/8-in. machine bolts with cotter key holes drilled in them. Castellated nuts are used which, with the cotter key prevents the liners from coming loose. The brass liners are cast with pockets in them to catch the grease that is fed to the liners by means of an ordinary grease cup, through the hole in the engine truck box at M, Fig. 2.

The trailer boxes are changed from their original design by cutting pieces of steel shaped as shown at L, Fig. 4, and then welded to the original box at the points marked N-N by either the acetylene or electric method. These pieces are cut out with a tee slot shown at G, Fig. 4. These slots are made so that the bolts which hold the trailer hub liner in place can be slipped in through these slots and a new liner applied without dropping the trailer wheels or any part of a trailer truck of the Delta type.

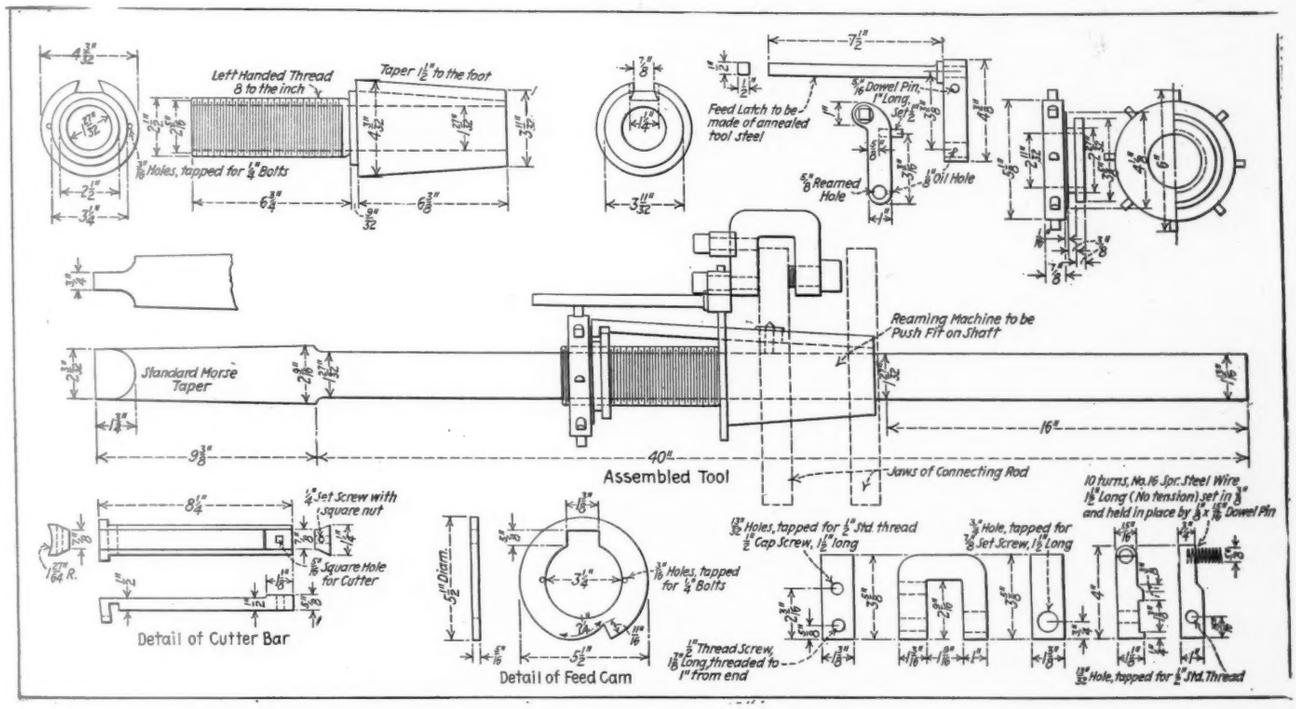
The holes in the corners of the trailer hub liners are drilled 1 5/16 in. for a 7/8-in. bolt. The hole is then counterbored 3/8 in. deep and 1 3/4 in. in diameter and then sawed out to the edge of the liner as shown in Fig. 3. When the bolts are slipped in place, a washer is placed on the bolt and as the washers fit into the counterbored part of the liner, they hold the bolts in place as long as there is a nut on them. With this arrangement the lateral can be taken up in a truck in about 1 hr., 30 min., where it formerly took five hours' time besides several men on the job and a great deal of handling in getting the old boxes off, pouring on the brass, facing it off and replacing.

Taper attachment for boring out side rods

By Alvah S. Duryea

Shop foreman, O.-W. R. R. & N. Co., La Grande, Ore.

THE taper attachment shown in the illustrations is used on a Lucas horizontal boring mill for reboring taper holes in side rods, although with a few minor changes it could be applied to several other classes of work. The reason for using this device is that we encountered considerable trouble in getting a reamer to give good service on crome-vanadium steel. It becomes hard and glazed in service with the result that the rods have first to be bored and then reamed. This practice necessitated the removal of considerable material. We can now bore a rod in 30 min., from floor to floor, removing from 1/32 in. to 3/32 in. of material.

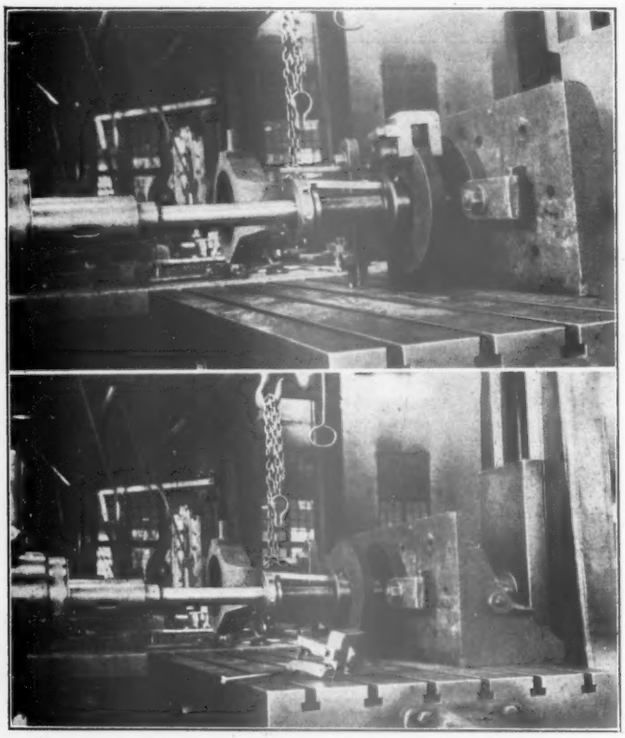

Left Handed Thread 8 to the inch
Taper 1/2" to the foot
Feed Latch to be made of annealed tool steel
Reaming Machine to be Push Fit on Shaft
Standard Morse Taper
Assembled Tool
Jaws of Connecting Rod
Detail of Cutter Bar
Detail of Feed Cam

Assembled view and details of tool for reaming connecting rods on a horizontal boring mill

When making this tool the two principal factors to consider are the lead of the screw and the movement of the dowel pins in the nut, and that the portion of the flange cut away must be greater than the space between two of the pins, and not equal to two spaces or the feed will be doubled.

The head or main portion of the tool is a push fit on

the shaft, having no movement relative to the shaft. The head is machined all over and is turned to the same taper as that of the hole to be bored. There is also a sufficient amount of clearance between it and the hole. It has a narrow flange or feed cam, the periphery of which is concentric with the body except that it is cut away a short distance to allow it to act as a cam. A dove-tail slot is planed parallel to the center line in the head to receive the cutter bar. The angle formed by the extended intersection of this slot with the center line of the bar is an important point on which depends the angle or taper of the hole the tool will bore. The cutter bar passes through a clearance hole in the flange and the end is fitted in a slot in the feed nut. The nut is threaded to the shaft and advances and recedes along the thread as it rotates on the shaft. Thus, as the bar is in rotation and the nut is held stationary both the head and collar will continue to rotate with the bar, while the cutter bar and the nut will



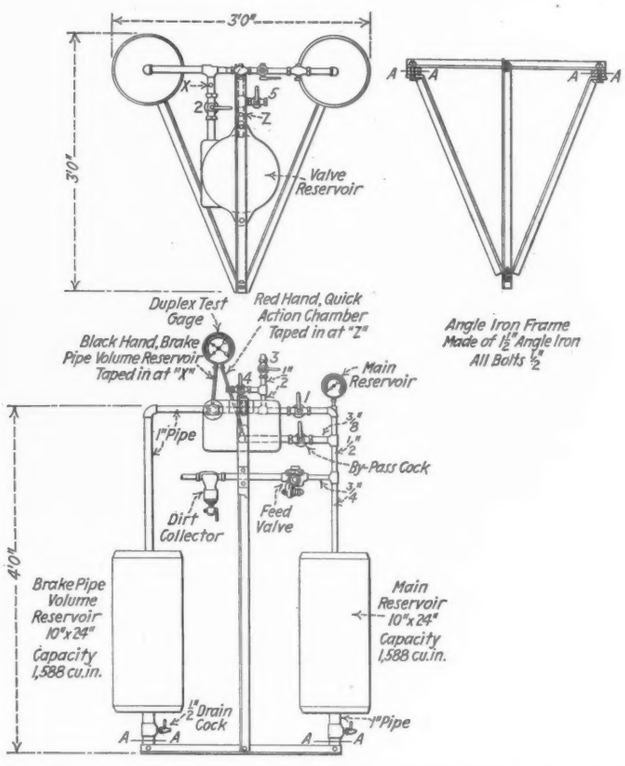
Top view shows the device in operation while the lower view shows the feed latch removed and lying on the table

move endwise with relation to the head at a rate dependent on the lead of the screw thread on the bar.

The cutting tool is a piece of high speed steel fastened by a set screw in a hole near the end of the cutter bar. All the movements necessary for taper boring are thus provided, but if the nut were to be held stationary either the thread on the bar would have to be a fine pitch or the feed would be altogether too coarse. Therefore, means are provided for retarding, or rather, intermittently stopping the rotation of the nut. This is done by a feed device or latch which is arranged to be fastened directly above the feed cam by a clamp. The diameter of the feed nut measured over the dowel pins should be the same as that of the feed cam. It follows, therefore, that if the bar revolves the hooked end of the cutter bar will ride on the flange of the threaded nut which continues to revolve with the bar. A portion of the flange has been cut away equal to a little more than the distance between the two dowel pins on the nut. When this recess reaches the feed latch it automatically drops, permitting the feed latch bar to engage one of the dowel pins holding the nut stationary. The head still revolves and on arriving at the high part of the cam releases the feed latch and allows the nut to revolve for another revolution. Since there are eight dowel pins in the nut, the tool is fed ⅛ of the thread on the bar, in this case approximately .012 in.

Rack for testing brake pipe vent valves

ALL of the No. 4 brake pipe vent valves repaired in the shops or enginehouses of an eastern railroad are tested on the rack shown in the drawings before being returned to service. The rack, a piping diagram of which is shown in one of the drawings, consists of two auxiliary 10-in. by 24-in. reservoirs, a cast iron reservoir, a duplex gage and single pointer gage, and five cocks, together with the necessary piping. This equipment is supported on a frame made of 1½-in. angle iron. Cock No. 1 is a ½-in. cut-out cock and cock No. 2 is a 1-in. cut-out cock with a side vent. Cocks Nos. 3 and 4 are bleed cocks with 5/32-in. and 13/64-in. chokes, respectively. Cock No. 5 is a quick action chamber bleed cock



Drawing of the rack for testing No. 4 brake pipe vent valves

and a ⅜-in. cock is placed in the by-pass line as shown in the piping diagram.

The vent valve to be tested is bolted to the cylindrical cast iron reservoir in the same manner as it is applied on the locomotive. It is then tested according to the following code.

Code for operating the test rack

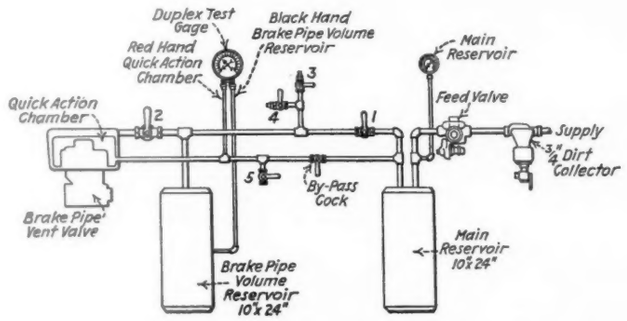
General—Before placing the vent valve on the rack, determine the friction of the piston and the slide valve by using the friction indicator, which is used for determining

friction on triple valves. The resistance to movement should not exceed 6 lb.

Make certain that the gasket between the valve portion and reservoir is in good condition and then place the vent valve on the rack. The feed valve should be set to close at 70 lb.

Charging test—Commence test with all cocks closed. Open Cock No. 1 and charge the brake pipe reservoir to 70 lb., then open Cock No. 2 and note the rate the pressure is built up on the gage leading to the quick action chamber. The charging time should be from zero to 65 lb. in 45 sec. to 80 sec. If a less time than 45 sec. is required for charging, check the No. 72 drill hole in the bushing underneath the ball check. If this is found to be the proper size, the faster charging time indicates ring leakage. At the same time, check the 1/16-in. hole in the cylinder bushing. Coat the entire valve with soap suds to detect leakage. If any leakage is found, the charging test should be repeated.

Slide valve and emergency valve leakage test—After the quick action chamber has been charged to 70 lb., place a bubble over the valve exhaust. Leakage here indicates either slide valve or emergency valve seat leakage. To



Piping diagram of the brake pipe vent valve test rack

determine which valve is leaking, open Cock No. 5, which vents quick action chamber pressure to the atmosphere. If the blow continues, it indicates emergency valve seat leakage.

Service stability test—Close Cock No. 5, open the by-pass cock, and recharge the quick action chamber to 70 lb. When recharged, close the by-pass cock and Cock No. 1, and open Cock No. 3. This should not produce emergency in a 20-lb. drop. If it does, it may be caused by a restricted quick action chamber port in the slide valve, a weak graduating spring, or high friction in the emergency piston. Close Cock No. 3 and place a bubble over the vent valve exhaust. Leakage here indicates that the slide valve is leaking.

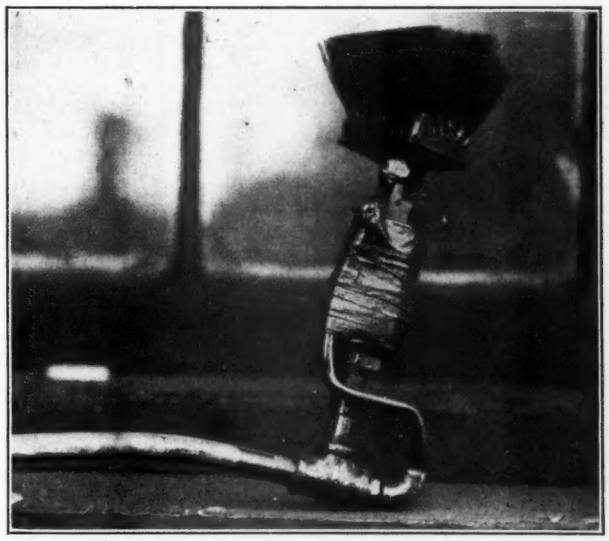
Emergency sensitiveness test—Open Cock No. 1 and the by-pass cock, and recharge to 70 lb. Close Cock No. 1 and by-pass cock, and open Cock No. 4. This should produce emergency within a 10-lb. drop. Failure to produce emergency may be due to a stuck emergency piston and a worn quick action piston ring. When emergency takes place, note the drop on the gage attached to the quick action chamber. This should be from 70 lb. to 5 lb. in not less than 10 sec. nor more than 15 sec. If less than 10 sec., it may be due to quick action piston ring leakage. If greater than 15 sec., it may be caused by a restricted vent hole in the quick action piston. Close Cock No. 4 and open Cock No. 1 slowly, and note that the quick action valve closes after emergency. Failure to close will be indicated to the operator by a continuous blow at the quick action exhaust.

A revolving window cleaner

GANG foreman, C. E. Mortlock of the Wilmington enginehouse, Maryland division of the Pennsylvania System, has devised a window washing apparatus that it is said will wash as many 12-in. by 12-in. windows around an enginehouse in one day as two men can wash

The window cleaning equipment in use

by hand in one week. It is operated by one man, using water and compressed air. A hose is connected to a water connection and another hose to an air supply. The water flows into the tank and is then forced by air from the tank up through a long ½-in. pipe which has a revolving brush on one end. The windows are thus quickly cleaned by the revolving brush.



A revolving window cleaning brush operated by compressed air and water

The information contained in the above article was supplied through the courtesy of the Pennsylvania News, published in the Eastern region of the Pennsylvania Railroad.

THE HEADQUARTERS of the Consolidated Purchasing Agency of the American Short Line Railroad Association, together with those of its manager, J. W. Cain, have been moved from Chicago to Houston, Tex.

The Reader's Page

Have You a Question? Ask it
Have You an Opinion? Express it

Tests of cast iron brake shoes—A question

SAN FRANCISCO, Cal.

TO THE EDITOR:

I have read with considerable interest F. H. Williams' article on comparative tests of cast iron brake shoes which appears in the April, 1926, issue of the *Railway Mechanical Engineer*. On page 211 there is a comparative statement showing the cost and wearing qualities of cast iron brake shoes, plain, chilled and with expanded metal. I am wondering whether the saving shown in this table takes into account the wear of the wheels.

It appears to me quite possible that while the expanded metal shoe shows less wear than the plain cast iron brake shoes, it may at the same time be causing more wear to the wheels than these shoes and it then becomes a question as to whether the saving in wear of the brake shoe is not offset by the additional loss in wear of the wheel.

DENNISTOWN WOOD,
Engineer of tests, Southern Pacific

The answer

MONTREAL, Que.

TO THE EDITOR:

I have no actual tests as to the wear on the wheels or tires by the various types of brake shoes, but I am of the opinion that the wear will be slight and practically the same in all cases. The first thing to be considered is the comparative area of contact of the shoes to the wheels, during one turn of the wheel. The area of the wheel surface to that of the shoe is approximately from ten to twenty to one. The wheel is much thicker and has more surface for the dissipation of the heat generated by the friction than the shoe. Therefore, the shoe heats up and naturally wears away quickly as compared with the surface of the wheel.

The structure of the metal in the shoe and in the wheel is the next consideration. By looking at the photomicrographs in the article in the April, 1926, issue of the *Railway Mechanical Engineer,* you will note that the hardest material is not in excess and that it is like a honeycomb and not a solid mass. It is imbedded in a softer material which is softer than either the tire or chilled wheel. The thin hard network will gradually break off and become set in this soft matrix, or fly off as burnt metal and be lost. This is the actual wear.

In the case of freight car wheels or any chilled wheel there is no question but that the wheel will not wear any more with the diamond mesh shoe than with the ordinary brake shoe, and decidedly not as much as with the chilled cast brake shoe which has a solid area of 8 to 12 sq. in. of chilled cast iron of the same structure as the wheel.

I am sure that the diamond mesh brake shoe is the medium hard shoe. The chilled cast or special chilled cast shoe is too hard and the ordinary cast shoe is too soft. I have no hesitation in recommending the diamond mesh shoe for both passenger and freight car service, especially for passenger car service.

FRED H. WILLIAMS,
Assistant test engineer, Canadian National

Why Walschaert valve gear pins break

BROWNWOOD, Tex.

TO THE EDITOR:

On page 458 of the July issue of the *Railway Mechanical Engineer* Mr. Lee wanted to know the reasons why a pin should break or fall from the union link of a Walschaert valve gear while a locomotive is running at a speed of 40 miles an hour. One cause for the breakage of the union link pin would be a stuck valve on account of the lack of proper lubrication owing to the fact that the locomotive on which the failure occurred was equipped with new cylinders. Steam pressure would never break the pin.

Another defect could have been that the end of the pin was not properly drawn up tight and a cotter pin put in place for safety. Another cause could be laid to defective material or to the use of chrome nickel steel casehardened the same way that an ordinary steel carbon pin would be treated. If an alloy steel pin is casehardened in this manner, it will quickly break under the vibration set up by the locomotive. The sudden jerks to which a locomotive is subjected when running at a high rate of speed are too severe on alloy steel pins which have not been properly treated.

The reasons for valve motion pin failures are often hard to determine, but the writer has found in his experience that when pins are reported broken or missing, the failure can generally be attributed to one of the above-mentioned causes.

B. G. MILLER.

Broken union link pin on a Walschaert gear

LOUISVILLE, Ky.

TO THE EDITOR:

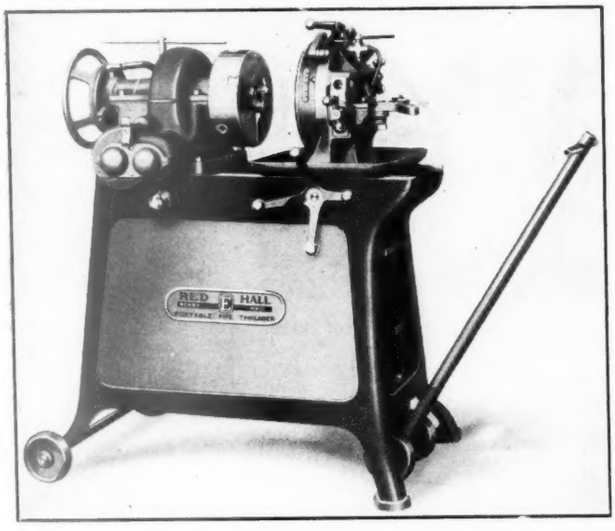
I read in the July, 1926, issue of the *Railway Mechanical Engineer* a question by C. M. Lee on the Walschaert valve gear and would also like to have the opinion of the readers relative to my conclusions as to why a cylinder fails due to the pin of a Walschaert valve gear breaking.

The road with which I am connected has had two or three cylinder failures of this kind. I am of the opinion that where a pin breaks or falls out of a union link, probably the valve stopped in a position covering the port, and the cylinder packing being in good condition and tight and the high speed at which the locomotive was running, created a high compression in the cylinder, causing it to break at the weaker point. In the failures referred to the cylinders were broken through the steam port and also through part of the valve chamber and exhaust cavity.

W. T. SPEAK.

Red-E-Hall portable electric pipe machine

HALL-WILL, INC., Erie, Pa., has recently placed on the market the first of a new line of tools known as the Red-E-Hall portable electric pipe machine. This machine is designed to handle pipe from ¼-in. to 2-in. pipe size and bolts from ½ in. to 1½ in. diam. It can also be used as a power unit, using a



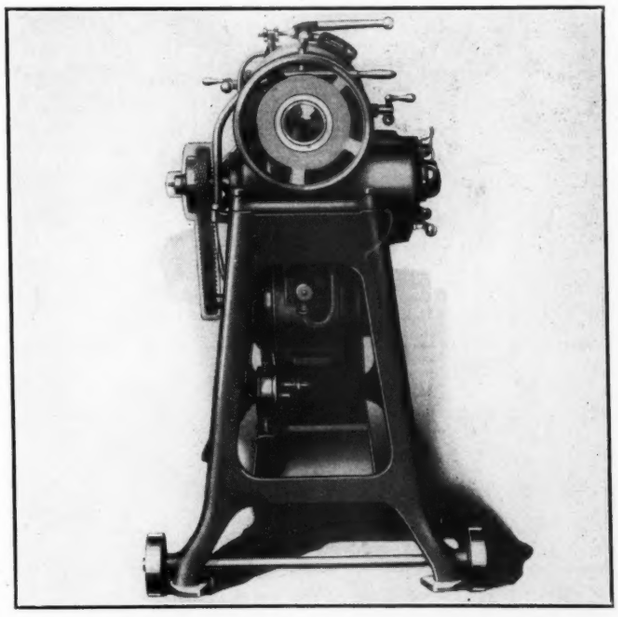
A new portable electric pipe machine which cuts and threads pipe from ¼ in. to 2 in.

universal shaft, to drive hand stocks up to 12 in. While designed as a portable machine it may easily be changed over to a stationary machine in a few minutes.

Malleable iron and steel are used throughout in its construction in order to eliminate the breakage of vital parts and to provide a light-weight machine, the weight in working order is only 450 lb. For use as a portable machine a built-in elevating truck is provided, the rear feet of the machine being mounted on small wheels while the front feet have double swivel casters which elevate the front end when the handle is moved forward.

The machine is driven by a 1-hp. reversible motor, operating at 1,750 r.p.m., which is bolted to the main frame in an easily accessible position. Push or turn button controls for stopping, starting or reversing are provided. A silent chain and friction clutch transmit the power to the spindle through a three-speed selective gear transmission running in an oil bath. The gears are of heat-treated chrome-nickel steel and the shafts are mounted in Timken roller bearings.

Close nipples can be threaded without extra equipment by the use of the standard chuck. The dies are opened and closed by means of a lever on top of the die head. The die head is designed so that once it has been set to a given size it can always be brought back to the same position by pulling down the lever to the locking position. Adjustment for oversize and undersize threads has



End view of the Red-E-Hall pipe machine, showing the location of the driving motor

also been provided for by turning two narrow nuts on the head bracket. The outside of the cam is graduated for setting the die head for various sizes of pipe. A positive locking device is provided on the head.

The cut-off attachment is of a new type with the block mounted on the front V-block of the machine. Adjustment of the tool block is made by means of a tapered steel

gib. The blade in the cut-off attachment is of high-speed steel tempered the entire length. A handle on the cut-off screw permits rapid operation of the cut-off tool. A double opposed V-block with interchangeable hardened steel plates holds the pipe steady for cutting off.

The rear block opposite the cut-off blade is made wider because of the fact that it takes most of the natural thrust and wear from the cut-off tool. In the front end of the bed is a chip pan and oil chute which delivers the cuttings to a chip box from the point where the oil drains off through two strainers to the oil reservoir below.

Cutting oil is forced into a chamber in the die head and three specially arranged outlets allow it to be distributed on the dies. The oil is pumped from a large oil reservoir by means of a rotary geared reversible oil pump driven direct from the main motor.

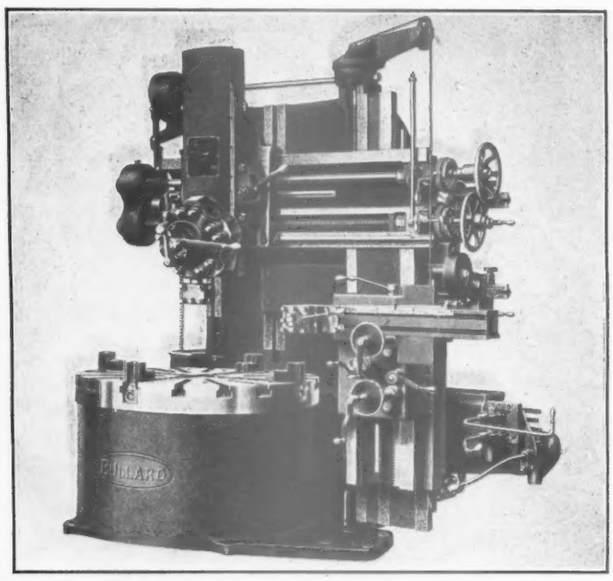
New Era 54-in. vertical turret lathe

AN improved vertical turret lathe of 54-in. capacity, with one swivel turret head and one non-swiveling side turret head has recently been placed on the market by the Bullard Machine Tool Company, Bridgeport, Conn. The machine shown in the accompanying illustration has a table diameter of 50-in., but will actually swing work 56 in. in diameter. The height under the cross-rail is 35½ in., and the maximum distance from the table to the turret face is 49 in.

The table and table spindle are of the standard Bullard type, with a bevel-gear table drive. The spindle thrust bearings are ground concentrically on a machine built especially for this purpose.

The bed casting of the machine has been strengthened, and machined pads are now provided on the bed for the support of a forming attachment bracket for the side head. The forming attachment is either of the plate type for such work as the crowning of pulleys, or of the universal type that may be set to cover a wide range of angles for machining bevel gears.

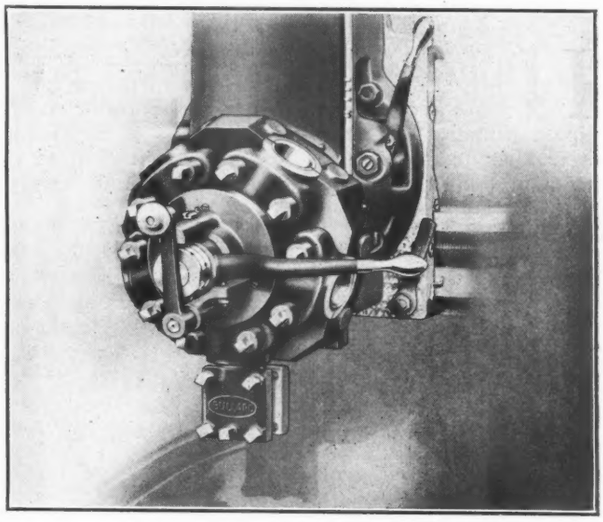
Other features that have been added to the machine include a cast-steel main slide, an all-steel turret, and a steel side-head slide. It is announced that these features will also be incorporated in the complete line of Bullard vertical turret lathes.



Bullard New Era 54-in. vertical turret lathe

The improved turret locking feature is made up of two steel rings screwed and doweled to the inner side of the turret and the face of the main slide. This construction provides five pairs of opposed bevel surfaces which mesh positively at the five points of turret registry. These rings are claimed to afford greater strength and accuracy, at the same time giving longer life. The all-steel construction of the turret and slide is intended also to increase the capacity of the machine for heavy cutting.

The side head has a vertical movement of 29-in. and a horizontal movement of 21-in. The head does not swivel. Quick hand movement in all directions is provided, as well as means for making fine adjustments independent of the feed works. A four-face turret toolholder is carried on the side head.



All-steel turret head

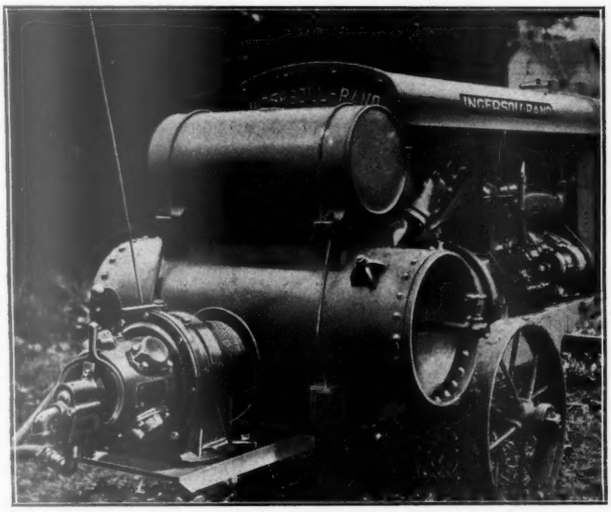
Special attention has been given to the lubrication of all working parts. An added feature of the machine is the adoption of pressure oil-gun lubrication for all bearings in the external units that are not reached by oil from the constant flow system or other unit reservoirs. An Alemite Zerk pressure oil gun is furnished as standard equipment with the machine.

The machine is intended either for countershaft or motor drive. When specified, the motor is fitted on a bracket at the rear of the machine and connected by a belt with the driving pulley. The net weight of the machine is 23,000 lb. No special foundation is required for the machine, which takes up a floor space 9 ft. 9 in. wide by 10 ft. deep. The total height of the machine, with the rail and slide in the highest position, is 10 ft. 9 in. The driving pulley is 24 in. in diameter and takes a 5-in. belt.

RIVETERS.—The Hanna Engineering Works, 1765 Elston avenue, Chicago, has issued a new catalogue descriptive of its compression and yoke riveters for boiler, tank, car, automotive and other industrial purposes. The various parts of the Hanna type riveter are shown in a full-page anatomical drawing.

Air hoist for use with portable air compressor

A NEW size DU utility air motor hoist has been developed by the Ingersoll-Rand Company, 11 Broadway, New York, which has been especially designed for use with portable compressors and is suitable for a wide variety of work. It is a hoist of general utility and is a suitable addition to any portable outfit.



Method of applying air hoist to a portable air compressor

It is a light, compact hoist of the winch type. It is provided with mountings by which it may be attached to the rear end of a 5½-in. by 5-in., or a 5-in. by 5-in. portable compressor, to the side of the larger compressors, or to compressors mounted on Ford trucks. In such cases it is always ready for use and adds but little to the overall dimensions and weight of the compressor. It is designed to exert a rope pull of 1,000 lb., and of taking 350 ft. of 5/16 in. cable. A swivel bolt through the bottom of the base permits the hoist to be swung around into any desired position.

The hoist is equipped with a clutch so that the cable can be easily played out by hand or by a down grade load without turning over the motor and consuming air. A hand brake on the drum is provided to check the unwinding and stop it in any desired position. The throttle control is sturdy and sensitive, so that any speed of rope travel can be obtained, from the very slightest movement up to a maximum speed of 65 ft. per min., although carrying a full load of 1,000 lb. at an air pressure of 80 lb. per sq. in.

A winch head can be furinshed in place of the rope drum.

The following are the principal dimensions of the DU motor: Capacity, 1,000 lb.; rope speed, 61 ft. per min. under load at 80 lb. air pressure; rope capacity, 350 ft., 5/16 in. diameter; width, 15 in.; length, 25⅜ in.; height, 19⅛ in.; net weight, 250 lb.

Rapid traverse side head 6-in. boring mill

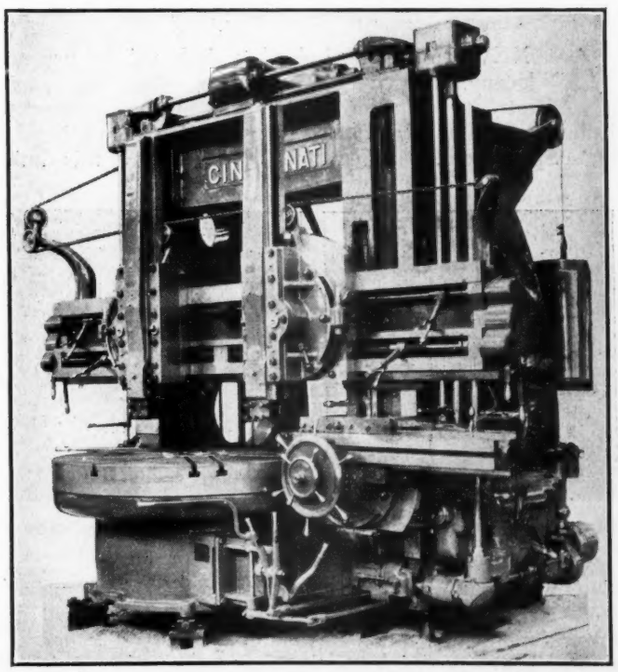
THE side head on the 6-in. boring mill, manufactured by the Cincinnati Planer Company, Cincinnati, O., has been designed to machine work of any height within the capacity of the mill. The ram and head construction permits a reach almost to the center of the table. The third head on the boring mill gives an opportunity to bore, face and turn at one time.

The feed box is placed on the side of the housing similar to that of the standard boring mill. Reverse of the feed can be obtained from gear boxes placed on either end of the feed box. The power feed can be used to feed the head up or down or feed the ram into the work.

The side head has a rapid power traverse in all directions, the power for which is obtained through an individual motor placed on the side of the housing. This motor is controlled with a drum type controller. Shifting of the lever connected to the controller changes the direction of the motor, giving rapid traverse up or down, or in and out. Throwing in the rapid power traverse lever automatically disengages the feed. The side head on the boring mill does not interfere with the use of the rapid traverse lever for the rail head and the levers for the side head are on the side of the machine in a convenient position.

The change levers for the table speed have been brought to the front of the machine in front of the side head. The start and stop levers have also been brought to the same position.

The construction of the housing and saddle is similar to that of the rail and saddle. The narrow guide has been embodied in the side head construction which eliminates twisting and other difficulties. The housing face has been considerably increased. This provides a strong, rigid housing and when securely bolted and dowelled to the bed, makes it possible to run the side head to the



All of the operating levers have been brought to the front of the machine for the convenience of the operator

extreme height and take large cuts. The ram, which is made of cast iron, has a steel rack bolted on it which provides an opportunity, in case of an accident, to replace the rail without throwing the entire ram away. Taper gibs are used throughout the head.

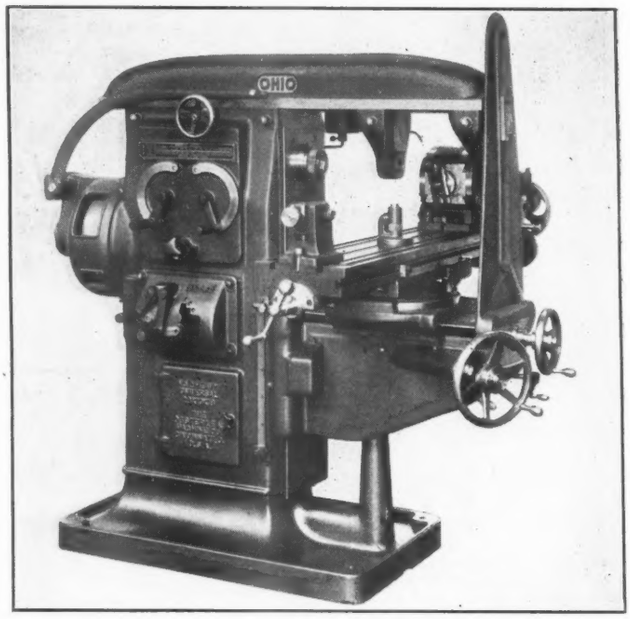
The side head can be provided with a crowning or taper attachment and, if necessary, also a thread cutting attachment. With these attachments it is possible to do any kind of work that would be placed on a boring mill in a railroad shop.

New Ohio milling machines

THE outstanding feature of the new Ohio constant speed or all geared milling machines, developed by the Oesterlein Machine Company, Cincinnati, Ohio, is the so-called Veeflat overarm. This is a heavy cast iron overarm of rectangular cross section, the name being derived from the vee and flat guides that form the bearing and provide alinement between the overarm and column. In addition to providing alinement of the arbor supports, this overarm forms a broad and rigid surface to receive the upward thrust of the cut. It is clamped by means of a pair of tee-slot bolts at the front and a pair at the rear of the column. Each pair equalizes and clamps by means of a nut at the side of the machine. The tee-slots in the overarm are placed as close to the vee and the flat contact surfaces as possible, so that the clamping pressure imposes no strain in the overarm or column.

The overarm is equipped with a rack that meshes with a pinion in the column. A handwheel is mounted on the end of the pinion shaft to provide a handy means of shifting the overarm. A feature of the overarm is the ease with which it may be handled for the replacement of arbors or cutters. The arbor supports may be placed on the arbor and the overarm slid forward into position by means of the handwheel.

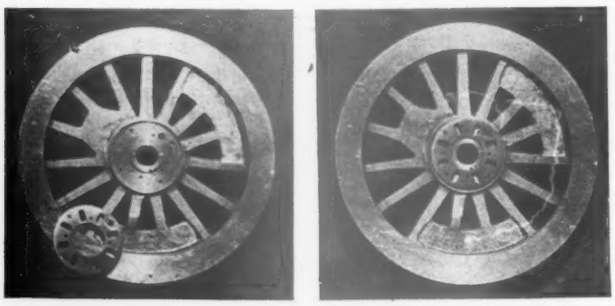
On both sides of the overarm are gaging strips. These are finished surfaces that are scraped parallel with the center line of the spindle.



A combination of el and flat surfaces is used in the design of the overarm on this milling machine

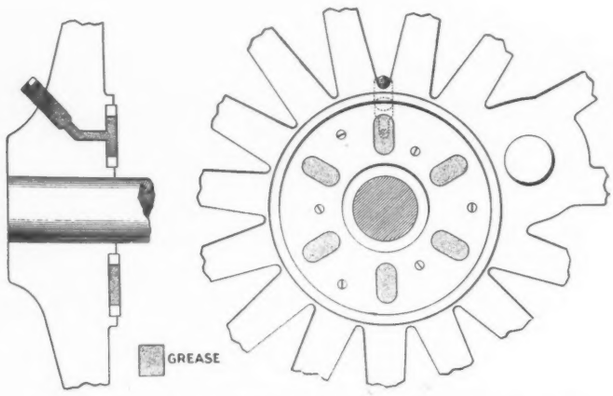
Lubricating hub plate reduces wear

A NEW lubricating hub plate designed for use on locomotive driving and trailer wheels is being introduced in the railroad field by the Christman Lubricating Hub Plate Company, 534 Landers building, Springfield, Mo. Work in developing this hub plate was begun a number of years ago and extensive tests on the St. Louis-San Francisco indicate that it lowers maintenance expense by permitting the operation of heavy power from shopping to shopping without taking up lateral play. It is being specified for all new power purchased by the Frisco and applications are made as present power passes through the shops for general repairs.



Christman lubricating hub plate before and after application

The Christman hub plate is little more than an ordinary hub plate with a special lubricating arrangement consisting of six elliptical holes through the plate to serve as grease pockets in conjunction with a grease plug hole in the hub for filling purposes. The hub plates



Method of applying the Christman lubricating hub plate

are finished all over and applied to new wheels before assembly on the axle. The location on the wheel center is such that one of the pockets of the hub plate coincides with the opening of the grease plug hole through the hub. The plate is held in place in accordance with the railroad's standard practice.

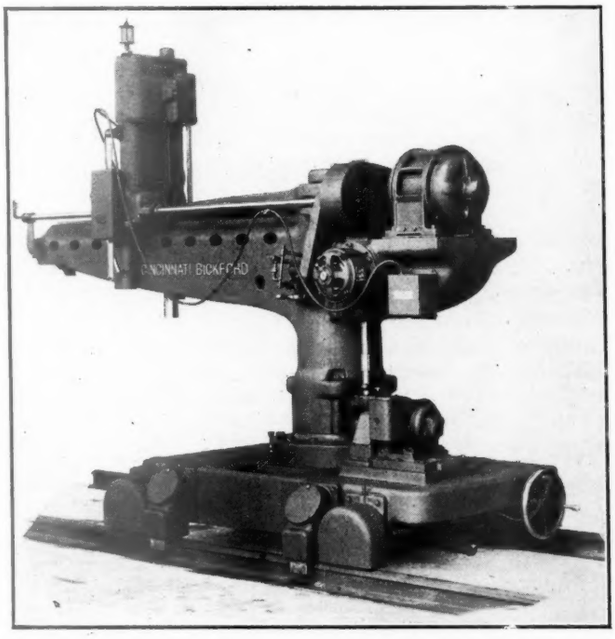
The exact location of the grease plug holes may vary somewhat with the pattern of the driving wheels, but it is important to locate them so that the grease plugs will at all times clear the side rods and when the engine is once spotted to have grease applied the grease plugs will be readily accessible on both sides of the engine. On most locomotives it is found that by locating the grease plugs as nearly as possible 90 deg. ahead of, or behind, the crank pins they will be readily accessible for removal and re-application in whatever position the locomotive is stopped. The grease plug holes should be such as to take the railroad's standard grease plug.

The Christman lubricating hub plate is applicable to locomotive trailer wheels in the same manner as to driving wheels except that it is not necessary to recess the hub of the wheel to receive the plate. The hub plate is simply fixed to the flat surface of the hub, the holes for lubrication being the same. These holes, as well as the grease cavity in the wheel hub, are filled with grease before application of the wheels under the locomotive thus assuring adequate lubrication at first while the plates are wearing to a smooth bearing against the hubs.

Multiple boiler plate drilling machine

THE heavy type plate and rivet hole drilling machine shown in the accompanying illustration was especially designed for boiler, tank, and structural shops. It is particularly adapted for drilling holes in duplicate plates and on that class of work it offers a production that is rarely exceeded except by multiple punching where the entire plate is punched at one stroke or where a spacing table is used.

The machine consists of a special type of radial drill, having the base mounted on wheels and arranged for travelling under its own power on a track parallel to a bench or trestle on which the plates are stacked. The method of operation consists of stacking as many plates as the length of the twist drill will permit. A plate from a previously drilled lot is used as a template. While one stack is being drilled another is being set up on the other end of the bench. The bench should be long enough to support two stacks, end to end, of the longest plates which are to be drilled. When one stack is finished the operator runs the machine under power to the other stack and continues drilling.



The Cincinnati Bickford heavy type plate and rivet hole drilling machine equipped with an electric column binder for the arm and cutting lubricant outfit

The economies claimed as a result of the use of this equipment are that only one man is required to operate the machine—helpers are not needed; the usual labor gang is used only to stack the plates on the bench prior to drilling and to remove those which have been drilled. Laying out of holes is practically eliminated as a plate from a previously drilled lot serves as a template. Idle machine time is negligible for it occurs only when the machine is travelling between two stacks of plates. In erecting, further economies are realized. Reaming is almost entirely eliminated because the duplication of holes in the plates is perfect. Easier and better riveting results, because the sides of the holes are straight and not tapered as is the case in punched holes. Drill breakage rarely occurs because of the extreme rigidity of the machine.

Unusual consideration has been given to manipulation. The control levers have been so located that each movement required of the operator is performed through the shortest possible distance and with the least amount of effort. The arm swings under the pressure of one finger. The head has been carefully balanced on the arm so that it moves easily and swiftly. A large hand wheel on the right of the head moves it one and one-quarter inches per revolution. Lost motion has been provided in the head moving mechanism which gives a hammer blow effect for quickly alining the drill with the hole in the template.

The feed trip automatically disengages the power feed when the drill penetrates the bottom plate of the stack. It acts directly on the main feed clutch instead of disengaging an auxiliary jaw clutch as is commonly done. As a result two less movements are required of the operator for each hole drilled. This feature effects a decided saving in time between holes.

Electric or air arm-clamping equipment is furnished on special order. On the former the arm is clamped by means of a small motor; on the latter, by a double acting air cylinder. The control of both devices is located on the head near the spindle and is so arranged that the operator clamps and unclamps the arm without leaving his operating position at the head. Where only hand clamping is used the operator is required to make two trips from the head to the column for each hole drilled. The time and energy saved by the use of either the electric or air arm-clamping equipment is considerable.

A countersinking attachment can also be furnished if desired. It consists of a long lever attached to the feed pinion shaft, which provides a powerful lever feed to the spindle. With this attachment the operator can

position the head and arm with one hand and countersink with the other.

The frame of the machine is of unusually heavy construction. The arm is of box section and is integral with the column sleeve. The column is the rigid member upon which the arm swings. It is heavily ribbed and is secured to the base with a wide flange which has almost twice the thickness of the ordinary flange. An exceptionally large amount of clamping surface on the lower part of the column is positive assurance against any side movement of the arm while drilling. This is an important factor in preventing drill breakage.

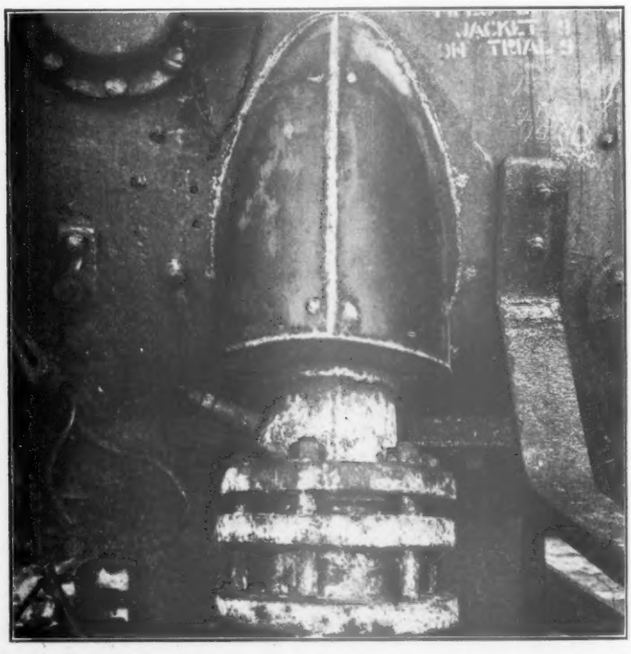
The base is strongly reinforced throughout with heavy flanged ribs. The machine is locked to the rails by four clamps located near the wheels. These clamps grip both sides of the rail head and are operated in unison by a large diameter hand wheel. An equalizing system insures uniform clamping. The wheels are of steel, machined and carbonized and are mounted on roller bearings. A two horse power motor, mounted on the base, furnishes power for propelling the machine on the track. It is geared direct to the axle through an enclosed worm drive and is controlled by a reversing drum type controller.

Speeds and feeds have been carefully selected. They are effectively graded to cover a wide range of drilling. A production of 800 11/16 inch diameter holes per hour in ¼ inch plates has been obtained with this machine.

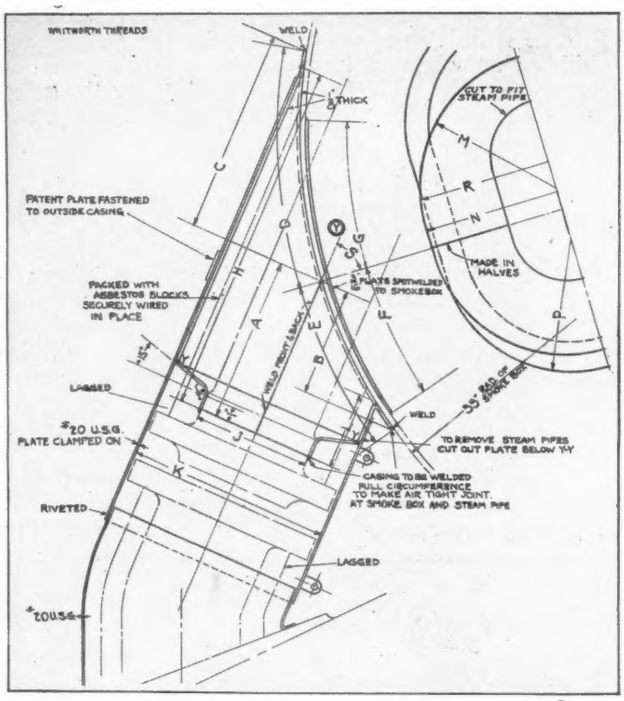
The machine is built in four sizes, having four, five, six, and seven foot arm lengths respectively. In addition to the heavy type plate and rivet hole driller the Cincinnati Bickford Tool Company, Cincinnati, Ohio, is prepared to furnish their standard radial drills mounted on the track type base.

Alco Flextite steam pipe casing

IT is a difficult problem to make an airtight closure around the hole cut in the smokebox sheets where the steam pipes pass through. Exclusion of air from the smokebox is imperative as it is conducive to poor drafting, which results in increased fuel consumption. The American Locomotive Company, 30 Church street, New York, is now using and supplying a patented arrangement whereby the casing is welded to the outside of the smokebox and around the steam pipes. First the steam pipes are covered with asbestos blocks securely wired in place. Then the ⅛-in. split casing is bolted in place around the steam pipes. The seams in the casing are then welded, it is welded to the smokebox and the lower end is welded to the steam pipe. There is sufficient flexibility in the casing to take care of the necessary expansion and contraction.



The Flexite steam pipe casing after the welding operation is completed


WHITWORTH THREADS
WELD
⅛" THICK
CUT TO FIT STEAM PIPE
PATENT PLATE FASTENED TO OUTSIDE CASING
PACKED WITH ASBESTOS BLOCKS SECURELY WIRED IN PLACE
⅛" PLATE SPOTWELDED TO SMOKEBOX
MADE IN HALVES
LAGGED
WELD FRONT & BACK
WELD
TO REMOVE STEAM PIPES CUT OUT PLATE BELOW YY
CASING TO BE WELDED FULL CIRCUMFERENCE TO MAKE AIR TIGHT JOINT AT SMOKE BOX AND STEAM PIPE
RIVETED
LAGGED

Method of laying out a casing for around a steam pipe

There is said to be a net saving in weight of approximately 80 lb. per locomotive and castings are eliminated, with attendant machine work and chipping. Properly welded, the casing will remain airtight indefinitely around the steam pipe.

The Railroad Labor Board has remanded to the parties in interest all pending disputes. At the time of the enactment of the new railroad labor legislation the Board's calendar had on it 426 dockets covering 468 disputes, 44 of which were of a general nature, affecting large groups of employees. Among the applications for wage increases were those of the Brotherhood of maintenance-of-way employees, affecting 31 roads. This case was heard last October, but decision had not been rendered. The Brotherhood of Railway and Steamship Clerks and 18 roads were involved in a pending application for wage increases upon which no hearing was held. Two cases involved request for wage increase by the Order of Railroad Telegraphers for the telegraphers on the Chicago, Burlington & Quincy and the Chicago Great Western. No decision had been rendered although the case was heard in September. The Brotherhood of Locomotive Firemen and Enginemen have requests for increases similar to those presented by the Order of Railway Conductors and the Brotherhood of Railroad Trainmen.

L. M. Parker, former secretary of the Labor Board, has been appointed custodian of the records of the Board and is in charge of closing up its affairs.

PROMOTIONS AND APPOINTMENTS I.C.C. THE SUPPLY TRADE

News of the Month

CLUB AND ASSOCIATION NEWS NEW TRADE PUBLICATIONS NEW SHOPS

The Boston & Maine announces that a joint board of labor adjustment has been established in the mechanical department to co-operate in the disposition of such grievances and disputes as may arise between management and men. This board will function along the lines followed by the board established jointly by the road and the brotherhood of clerks two years ago. A board of six members is created, three appointed by the association employees and three by the railroad, serving for terms of one year. Representatives of the association and of the railroad will alternate each six months in filling the positions of chairman and vice-chairman. Jurisdiction of the board is limited to disputes growing out of personal grieveances or out of interpretations or application of schedules or practices now in effect or hereafter established, and does not include proposed changes in rates of pay, rules or working conditions.

Safety Section circular No. 131

Of the casualties to railroad employees in the United States in 1925—1,599 killed and 119,224 injured—no less than 76 of the fatal and 589 of the non-fatal injuries happened to men who were not on duty. This is the main topic of Circular No. 131 which has been issued by the Committee on education, of the Safety section, A. R. A., embracing its program for the activities which it is desired shall be made the special business of the safety specialists on all railroads during the month of August. Riding on the side of a freight train to save a short walk is one of the more common occasions in which employees are injured when off duty; and the circular contains two pictures, one of which emphasizes the fact that many of these employees are those in the clerical service, with no possible excuse for endangering their lives on the railroad any more than would a school teacher or a clergyman.

Rock Island to motorize on branch and main line

The Chicago, Rock Island & Pacific has prepared plans for the use of gas-electric cars on some of its branch and main lines. The purchase of the first seven units in the program has been authorized and when installed they will be assigned to branch lines in Iowa and Oklahoma. The motive power to be used is of the gas-electric type, employing a petroleum distillate for fuel. The use of the new motor cars on the main lines will result in eliminating local stops for through trains and will materially speed up the through train service.

These new motor units will include double power plants and four motors of such design that either one or both power plants with corresponding motors can be used to meet the operation of heavy trains. The motors will be of 275 hp. each. One of the advantages to be secured through the proposed motorization program is that existing equipment can be converted into motor units by building the motors into the cars. The 45-ton steel Rock Island mail cars now in use on the regular trains are to be thus converted and be made available at once.

Wage statistics for April

The number of employees reported by Class I railroads to the Interstate Commerce Commission for the month of April, 1926, was 1,783,411, an increase of 37,997, or 2.2 per cent over the number reported for March, 1926. Owing to seasonal requirements, the number of employees in the maintenance of way group shows an increase of 44,107, but this number was slightly offset by reductions in the maintenance of equipment, and the transportation groups. The total compensation, $242,943,370, shows a decrease of $6,684,887, or 2.7 per cent. This decrease in compensation in the face of an increase in employment is explained by the fact that April had only 26 working days while March had 27. It is also noted that the principal increase in employment occured in the number of lower paid employees.

Compared with the returns for the corresponding month last year, the number of employees reported in April, 1926, increased 2.2 per cent, and the total compensation increased 3.5 per cent. As indicated in the subjoined table, the increase in employment appears largely in the maintenance of way, and the transportation groups. The difference between the percentage increase in employment and in compensation is due to slight increases in the number of hours worked per employee and in the average rates paid.

Court news

Cars Chained Together for Twin Loads not Violation of Law.—The federal district court for southern Texas holds that the purpose of the Safety Appliance Act is remedial, to obtain safety, rather than penal, to exact retribution. Two cars which had moved as a twin load, having their coupling attachments disconnected and being chained in rigid fashion for safety, were being returned for repairs to the initial carrier, there being a repair track of the connecting carrier much nearer the place of unloading. It is held that there was no violation of Section 2 of the act. Either the two cars joined became one car, or the fundamental purpose of Section 2 to conserve the safety of the persons engaged in coupling and uncoupling the cars was not affected, since the cars were not to be and could not be coupled or uncoupled in ordinary railroad usage.—U. S. v. 1.-G. N. 9 F. (2d) 142.

Failure to Comply with Boiler Inspection Act.—A conductor was riding in an engine cab when the main pin broke, punching a hole in the boiler. The men on the engine jumped to save their lives. In so doing, the conductor received fatal injuries. In an action for his death, under the Boiler Inspection Act, the Circuit Court of Appeals, Second Circuit, holds, Hough, C. J., dissenting, that the Boiler Inspection Act imposed an absolute duty on the railroad to have the engine boiler and its appurtenances safe to operate, making the railroad an insurer of the safety of the place in which the employee works and of the appliances with which he works. But it must appear that the railroad's failure to comply with the act was the proximate cause of the accident.—Lehigh Valley v. Beltz, 10 F. (2d), 74.

Meetings and Conventions

Southern and Southwestern Railway Club holds annual outing

The annual outing of the Southern and Southwestern Railway Club was held in Atlanta, Ga., Thursday, July 15. The forenoon was devoted to a business meeting. A. J. Law (master mechanic, N. C. & St. L.), president of the club, presided. Minutes of previous meeting were read and new members balloted upon. A. G. Pack, chief Bureau of Locomotive Inspection, was to have read a paper entitled, "The Advantages of Organization and the Maintenance of Motive Power," but he was unable to be present. His paper, however, will be printed in the next proceedings. The meeting adjourned promptly at noon and buses transported the members to a nearby park where an old-

fashioned barbecue was indulged in. Members also had the pleasure of visiting a house which is an exact replica of the old home of Robert Burns in Scotland. Every detail was complete, including the furnishings.

Fall meeting of the American Welding Society

The fall meeting of the American Welding Society will be held in Buffalo, November 17, 18 and 19. An international welding and cutting exposition will be held in connection with the meeting, which will open Tuesday afternoon, November 16. The technical sessions include railroad welding apparatus, welding science in the engineering curriculum of universities, and welding in a gaseous atmosphere. The entertainment includes a trip to Niagara Falls, a view of the Falls from the American side, with an inspection trip through the Niagara Falls power house, a buffet supper on the Canadian side and a special illumination of the Falls. There will be the usual annual fall banquet and a meeting of the American Bureau of Welding, the Board of Directors and the Welding Wire Specifications Committee.

Master Blacksmiths convene at Cleveland, August 17

The International Railroad Master Blacksmiths' Association will hold its thirtieth annual convention August 17, 18 and 19 at the Hotel Winton, Cleveland, Ohio. There will also be an exhibit held in conjunction with the convention under the auspices of the International Railroad Master Blacksmiths Supply Men's Association, of which James A. Murray, Ajax Manufacturing Company, is president. The program consists of committee reports on a total of ten subjects which are as follows: Autogenous Welding, A. W. Young (N. Y., N. H. & H.), chairman; Carbon and High Speed Steel, Frank P. Diessler (B. & L. E.), chairman; Drop and Machine Forging, C. C. Ferguson (N. P.), chairman; Drawbars and Drawbar Pins, C. D. Hayes (N. P.), chairman; Frame Making and Repairing, John P. Reid (M. P.), chairman; Heat Treatment of Steel and Iron, T. F. Buckley (D. L. & W.), chairman; Reclamation, H. Wright (P. M.), chairman; Spring Making and Repairing, J. B. Ray (M. P.), chairman; Safety First, J. J. Haggerty (N. Y. C.), chairman; and Tools and Formers, C. A. Wagner (N. Y. C.), chairman.

Tool Foremen to meet at Chicago

The fourteenth annual convention of the American Railway Tool Foremen's Association will be held at the Hotel Sherman, Chicago, September 1, 2 and 3. The program arranged for this meeting is as follows:

Wednesday, September 1

9:30 a. m. (Daylight Saving Time)

Address by L. A. Richardson, general superintendent of motive power, Chicago, Rock Island & Pacific.
Address by President E. A. Hildebrandt.
Report of secretary-treasurer.
Appointment of committees.
Unfinished business.
New business.

2 p. m.

Report of Standing Committee on New Labor-Saving Tools and Devices for the Air Brake Department, H. Otto, chairman.
Report of Standing Committee on Training of Men Suitable for Toolroom Work, J. J. Sheehan, chairman.

Thursday, September 2

9:30 a. m.

Address, "Simplification, a New Tool for the Tool Foreman," by Edwin W. Ely, assistant director, Department of Commerce.
Report of Standing Committee on Standardization of Present Special Boiler Taps, O. D. Kinsey, chairman.
Report of Standing Committee on New Tools and Safety Devices for the Car Department, G. Reichart, chairman.
Election of officers.
Special visit to exhibits.

Friday, September 3

9:30 a. m.

Report of Standing Committee on General Locomotive Shop Kinks and Devices, J. E. Carroll, chairman.
Report of Standardization Committee, E. J. McKernan, chairman.
Report of Committee on Auditing, Committee on Thanks, and other special committees.
Selection of place for annual convention.
Adjournment.

General Foremen's Association convention

The following program has been arranged for the annual convention of the International Railway General Foremen's Association, which will be held at the Hotel Sherman, Chicago, September 7 to 10, inclusive:

Tuesday, Septtember 7

9:30 a. m.

Address of welcome by Mayor Dever.
Response by Pres. H. E. Warner.
Address, "The possibilities of the General Foremen's Association," by E. L. Woodward, western editor, *Railway Mechanical Engineer.*
Response, J. N. Chapman.
President Warner's address.
Report of secretary-treasurer.
Appointment of committees.

2 p. m.

Topic No. 1—Balancing shop sub-departments.
Locomotive department, E. F. McCarthy, chairman.
Car department, A. H. Keys, chairman.
Discussion.

Wednesday, September 8

9 a. m.

Address by L. C. Dickert, superintendent motive power, Central of Georgia.
Response, A. H. Keys.
Response, T. C. Gray, supervisor of apprentices, Missouri-Kansas-Texas.
Topic No. 2—Development of the mechanic, R. J. Farrington, chairman.
Discussion.

2 p. m.

Topic No. 3—Maintenance of refrigerator car, J. N. Chapman, chairman.
Discussion.
Election of officers.

Thursday, September 9

9 a. m.

Address by D. C. Curtis, chief purchasing officer, Chicago, Milwaukee & St. Paul.
Response, F. M. A'Hearn.
Topic No. 4—The general foremen's responsibility for material surplus or shortage, F. M. A'Hearn, chairman.
Discussion.

2 p. m.

Address by F. H. Becherer, assistant to mechanical superintendent, Boston & Maine.
Response, W. F. Lauer.
Topic No. 5—Developing railroad shop foreman, J. R. Leveridge, chairman.
Discussion.

Friday, September 10

9 a. m.

Address by M. A. Hall, superintendent machinery, Kansas City Southern.
Response, F. B. Harmon.
Topic No. 6—Modern shop equipment as a factor in increased production, H. W. Harter, chairman.
Discussion.
Reports of committees.
Unfinished business.
New business.
Adjournment.

Southeastern Air Brake Club meets at Atlanta

The second regular meeting of the Southeastern Air Brake Club was held on the roof garden of the Ansley Hotel, Atlanta, Ga., July 16. One hundred sixteen members and visitors were in attendance. A paper on the maintenance of passenger brakes was read by W. D. Herndon of the Jacksonville Terminal Company. This paper was discussed at some length, the discussion finally branching off to brake pipe leakage and proper lubrication of brake cylinders. It was the general opinion of the club members that just enough lubricant to properly lubricate the walls of the cylinders should be used. It was also brought out that improper clamping of pipes and pulling the hose apart were responsible for a major portion of brake pipe leakage. A. S. Benton of the Westinghouse Traction Brake Company also presented a paper on automotive brakes. Lantern slides were used to show the changes made in the U-12 Universal valve to incorporate the quick-service feature. T. W. Newburn of the Westinghouse Air Brake Company explained the changes necessary to convert the U-12 Universal valve to a U-12-B Universal valve. Fred W. Venton, assistant manager of the Crane Company, read a paper on pipe fittings, and J. H. Ainsworth, director of railroad sales of the A. M. Byers Company, read a paper on piping. These papers were turned over to the Recommended Practice Committee with a view of having them presented at the next convention of the Air Brake Association which is to be held at Washington, D. C., in May, 1927.

Summer outing of the New York Railroad Club

The New York Railroad Club held its third annual outing or mid-summer festival at the New York Athletic Club, Travers Island, and at the Winged Foot Golf Club, Mamaroneck, N. Y. on Thursday, July 8. A large number of those who attended motored to Travers Island and a special train on the New York, New Haven & Hartford left New York at noon. The Long Island Railroad Band played en route and headed the procession in the march from the station at Pelham Manor to Travers Island. A buffet luncheon and dinner were served at the clubhouse and the party returned to New York on a special train late in the evening.

Among the various forms of relaxation which were a part of the outing were a number of competitive sports in which prizes were awarded. These included a golf tournament at the Winged Foot Golf Club in the morning and a tennis tournament and track meet at Travers Island in the afternoon. A variety of prizes was offered in the golf tournament covering low gross, low net, "kickers" handicap, and others, the winners of prizes being as follows: Albert Hedley, Sterlip Press, Inc.; H. B. Weatherwax, vice-president, Delaware & Hudson Traction Lines; L. O. Smith, vice-president, Columbian Machine Works & Malleable Iron Co.; Elisha Lee, vice-president, Pennsylvania Railroad; Harry B. Doyle, Doyle, Kitchen & McCormick; Carl H. Beck, assistant eastern manager, Westinghouse Air Brake Company; J. D. McLean, W. A. Callison, W. W. Krider, T. L. Harrigan, J. Schneider, A. Schneider, S. P. Hull, Cupid R. Black, Richard Devans, J. J. Dunne.

Long Island employees won first places in all but one of the track events. The results of the track meet were as follows: 100-yd. dash won by K. Wildermuth, Long Island, 10⅖ sec.; 220-yd. dash won by E. O'Shea, Long Island, 24 sec.; 440-yd. dash won by E. Shotter, Long Island, 54 sec.; 880-yd. run won by O. Rosener, Long Island, 2 min., 3⅖ sec.; one-mile relay race for company teams, won by the Safety Car Heating & Lighting Company, with the Long Island second, and the Erie railroad relay team, third.

In the tennis tournament, the singles were won by E. A. Rudy, with C. P. Richenberg, runner-up, both of the Baltimore & Ohio. The doubles tournament was won by A. C. Home of the White Company and C. W. Squer of the Electric Railway Journal, the runner-up being A. A. Borgading of the American Car & Foundry, and W. B. Johnson of Ross F. Hayes. Other special features were swimming, quoits and a baseball game between Erie and New York Central teams which was won by the former with a score of eleven to three.

The quoit pitching contest was won by H. W. Mowery, American Abrasive Metal Company with Maxwell King, Atlantic Fruit Company, second.

J. S. Doyle, assistant general manager of the Interborough Rapid Transit Company, who was general chairman of the annual outing committee was unable to attend, due to the labor troubles on the Interborough.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs.

AIR-BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

AMERICAN RAILROAD MASTER TINNERS' COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—C. Borcherdt, 202 North Hamlin Ave., Chicago.

AMERICAN RAILWAY ASSOCIATION, DIVISION V.—MECHANICAL.—V. R. Hawthorne, 431 South Dearborn St., Chicago.
DIVISION V.—EQUIPMENT PAINTING SECTION.—V. R. Hawthorne, Chicago. Next meeting September 21-23, Book-Cadillac Hotel, Detroit, Mich.
DIVISION VI.—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey St., New York.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet Ave., Chicago. Annual convention September 1-3, Hotel Sherman, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, Marion B. Richardson, associate editor, *Railway Mechanical Engineer*, 30 Church St., New York.

AMERICAN SOCIETY FOR STEEL TREATING.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention September 20-24, Municipal Pier, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andrucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill. Annual meeting October 27-30, Chicago.

BIRMINGHAM CAR FOREMEN AND CAR INSPECTORS' ASSOCIATION.—P. H. Gillean, 715 South Eightieth Place, Birmingham, Ala. Meeting second Monday in each month at Birmingham Y. M. C. A. Building.

CANADIAN RAILWAY CLUB.—C. R. Crook, 129 Charron St., Montreal, Que. Regular meetings second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal, Que.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, Great Northern Hotel, Chicago, Ill.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—R. E. Giger, 721 North 23rd St., E. St. Louis, Ill. Meetings, first Tuesday in month, except June, July and August, at the American Hotel Annex, St. Louis.

CAR FOREMEN'S CLUB OF LOS ANGELES.—J. W. Krause, 514 East Eighth St., Los Angeles, Cal. Meeting second Friday of each month in the Pacific Electric Club Building, Los Angeles, Cal.

CENTRAL RAILWAY CLUB.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Regular meetings, second Thursday each month, except June, July and August. Hotel Statler, Buffalo, N. Y.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—A. S. Sternberg, Belt Railway. Clearing Station, Chicago. Convention September 21, 22 and 23. Hotel Sherman, Chicago.

CINCINNATI RAILWAY CLUB.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meetings, second Tuesday, February, May, September and November.

CLEVELAND STEAM RAILWAY CLUB.—F. L. Frericks, 14416 Adler Ave., Cleveland, Ohio. Meetings first Monday each month except July, August and September, at Hotel Hollenden, East Sixth and Superior Ave., Cleveland, Ohio.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. Next convention August 17-19, Hotel Winton, Cleveland, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. B. Hutchinson, 1809 Capital Ave., Omaha, Neb.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabash Ave., Winona, Minn. Annual convention September 7-10, Hotel Sherman, Chicago.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 26 Cortlandt St., New York.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Regular meeting second Tuesday in month, except June, July, August and September. Copley-Plaza Hotel, Boston, Mass.

NEW YORK RAILROAD CLUB.—H. D. Vought, 26 Cortlandt St., New York. Meetings third Friday in each month, except June, July and August, at 29 West Thirty-ninth St., New York.

PACIFIC RAILWAY CLUB.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately.

RAILWAY CLUB OF GREENVILLE.—F. D. Castor, clerk, maintenance of way department, Bessemer & Lake Erie, Greenville, Pa. Meeting last Friday of each month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August. Fort Pitt Hotel, Pittsburgh, Pa.

ST. LOUIS RAILWAY CLUB.—B. W. Frauenthal, Union Station, St. Louis, Mo. Regular meetings, second Friday in each month, except June, July and August.

SOUTHEASTERN CARMEN'S INTERCHANGE ASSOCIATION.—J. E. Rubley, Southern Railway Shops, Atlanta, Ga.

TEXAS CAR FOREMEN'S ASSOCIATION.—A. I. Parish, 106 West Front St., Fort Worth, Tex. Regular meetings, first Tuesday in each month. Terminal Hotel Bldg., Fort Worth, Tex.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio. Annual meeting September 14-17, Hotel Sherman, Chicago.

WESTERN RAILWAY CLUB.—Bruce V. Crandall, 226 W. Jackson Blvd., Chicago. Regular meetings, third Monday in each month, except June, July and August.

Supply Trade Notes

Robert P. Moiser has been appointed manager of foreign sales of the Morton Manufacturing Company, with headquarters at Chicago.

The Electro-Motive Company, Cleveland, Ohio, has opened an office in Room 1029, Peoples Gas building, Chicago, in charge of J. F. Sattley.

A. O. Norton, Inc., has opened an office at San Francisco, Calif., and will be directly represented by Harry H. Hale, who has charge of the Pacific coast territory.

H. W. Kidwell, formerly of the National Railway Appliance Company, is now covering the southern territory for L. O. Cameron, handling Dupont Company products.

B. M. Horter, formerly of the Philadelphia office of the Cutler-Hammer Manufacturing Company, has been appointed manager of the Boston office, to succeed J. M. Fernald, resigned.

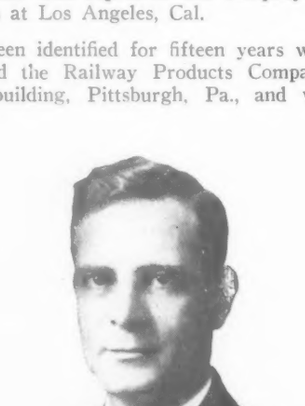
William H. Payne, manager of the Portland branch of the Yates-American Machine Company, has been elected vice-president in charge of all operations, with headquarters at Beloit, Wis.

R. P. Kelley, assistant advertising manager of the Autocar Company, Ardmore, Pa., has resigned to become advertising manager of the Timken Roller Bearing Company, with headquarters at Canton, Ohio.

George E. Watts, formerly with the Duff Manufacturing Company, Pittsburgh, Pa., has joined the Timken-Detroit Axle Company, Detroit, Mich., as a railway representative, with his headquarters in Atlanta, Ga.

H. C. Vickerman, formerly with the Oil Well Supply Company, has joined the sales force of the Reading Iron Company, Reading, Pa. Mr. Vickerman will represent the company in California, with headquarters at Los Angeles, Cal.

Tom C. King, who has been identified for fifteen years with railroad sales, has organized the Railway Products Company, 908 First National Bank building, Pittsburgh, Pa., and will serve as its president. Mr. King was formerly connected with the Kilby Car & Foundry Company and the Anniston Steel Company, Anniston, Ala. Later he organized the National Forge Company at Anniston and served as its secretary and treasurer until the company's plant was moved to Louisville, Ky., when he was appointed vice-president, with headquarters at that city. In 1923 he became manager of railroad sales for the Pittsburgh Knife & Forge Company. The Railway Products Company handles all railroad sales for the Pittsburgh Knife & Forge Company and the Keystone Bronze Company, Pittsburgh; also handles sales for the Neely Nut & Bolt Company, Pittsburgh; Greenville Steel Car Company, Greenville, Pa.; W. H. Miner, and the Symington Company, in restricted territory and in special cases.



T. C. King

F. E. Case, who for many years has been in charge of the railway equipment engineering department, of the General Electric Company, Schenectady, N. Y., has had added to his duties the supervision of the railway motor and railway locomotive engineering departments.

Frank N. Grigg, who for a number of years has been southeastern representative of the Heywood-Wakefield Company, Wakefield, Mass., railway car seat department, has tended his resignation with the company to take effect September 1.

Charles E. Stone, assistant to the president of the Chain Belt Company, Milwaukee, Wis., has resigned to become vice-president and general manager of the Interstate Drop Forge Company. C. C. Brenner, controller of the latter company, has been elected secretary.

D. W. McGeorge has been appointed sales engineer of the Birdsboro Steel Foundry & Machine Company, Birdsboro, Pa., manufacturer of hydraulic presses, rolling mill machinery, steel castings, etc. Mr. McGeorge was previously connected with the sales department of the Edgewater Steel Company, Pittsburgh, Pa.

Grafton Greenough, vice-president of the Baldwin Locomotive Works, in charge of domestic sales, died on July 8 at the Hahnemann hospital, Philadelphia, Pa., after an illness of only a few days. He was in his sixtieth year. Mr. Greenough was a native of Philadelphia, and was educated in the public schools of that city. He served an apprenticeship in the plant of the I. P. Morris Company, Port Richmond, which later became part of the William Cramp & Sons Ship & Engine Building Company. His career with the Baldwin Locomotive Works started on December 28, 1885, when he entered the engineering department as a draftsman and designer. In August, 1899, he was transferred to the operating department, serving as assistant superintendent and plant engineer. At the time of the Louisiana Purchase Exposition in 1904, he was placed in charge of the St. Louis office, later assuming charge of the sales organization in Philadelphia as general sales manager. In September, 1917, he was appointed vice-president in charge of sales, and in March, 1919, when a separate foreign sales department was organized, his title was changed to vice president in charge of domestic sales. Mr. Greenough was national councilor of the American Chamber of Commerce of Mexico, and was a member of a number of clubs and several other organizations. In connection with his work in the sales department, he was a close student of locomotive design and took an active interest in the development of railroad motive power.

Grafton Greenough

The St. Louis Car Company, St. Louis, Mo., is constructing two additional units to its plant. One building, 1,000 ft. by 130 ft., will be used for steel fabricating and the construction of cars and will be equipped with four 10-ton cranes of 60-ft. span, while the second building, 100 ft. by 60 ft., will be used for housing light steel materials.

A. Milton Buck has joined the sales force of the Bridgeport Brass Company, Bridgeport, Conn. Mr. Buck will have his headquarters at Washington, D. C., and his territory will include Washington, D. C., the states of Maryland, Virginia and West Virginia. He will specialize on sales of Bridgeport-Keating flush valves and Plumrite brass pipe.

Charles W. Harris, of San Francisco, Cal., has been selected to build up a sales organization for the Dunn Painting Machine Company, of the same city. Robert S. Weintraub, formerly with the Weinstock-Nichols Company, San Francisco, has been appointed special representative for the Dunn Painting Machine Company, with headquarters at San Francisco.

L. F. Kuhman has been appointed vice-president and director of the Andrews-Bradshaw Company, Pittsburgh, Pa., sales man-

ager for the Tracyfier steam purifier and gas and vapor scrubber. Mr. Kuhman has been associated with the company for the past three and a half years, and prior to that time, he was for eight years sales engineer for the Ingersoll-Rand Company in the Pittsburgh district.

The C. A. Mauk Lumber Co., Toledo, Ohio, handling west coast and southern lumber, has established a new department, catering to the railroad and car shop trade, with H. J. Fletcher in charge. Mr. Fletcher was formerly sales-representative of the Germain Company, with headquarters in Chicago, and lately with the W. L. Shepherd Lumber Company, as sales-manager of its railroad and car material department.

Charles S. Orne has been appointed manager of the Central Steel & Supply Company, Railway Exchange building, Chicago, Ill. This company represents the Ross-Tacony Crucible Company, William F. Jobbins, Inc., Neely Nut & Bolt Company; Rockford Malleable Iron Works and the Riverside Iron Works. A. A. Orne has charge of casting sales and I. R. Robinson specializes on crucibles and stopper heads.

Arthur A. Helwig, representative of the Bradford Corporation, with headquarters at St. Louis, Mo., has been promoted to manager of the southwestern district, with the same headquarters, to succeed W. C. Doering, who has been elected vice-president, with headquarters in Chicago. George W. Bender, representative, with headquarters in Chicago, has been promoted to manager of the northwestern district, with headquarters at St. Paul, Minn.

Laurence Thompson has been appointed district manager of the Cleveland office of the United States Electrical Tool Company, with headquarters at 555 Erie building. Mr. Thompson was formerly Cleveland manager of Fairbanks Morse. Wm. J. McFarland has been placed in charge of the company's new Detroit offices at 2-226 General Motors building. The company has installed its own aluminum foundry at its Cincinnati Works and is now turning out its own aluminum castings for portable electric drills.

G. LaRue Masters, who for the past five and one half years has represented the car window equipment department of the National Lock Washer Company, Newark, N. J., in the east, has been placed in charge of the sales of this department for the entire United States and Canada, under the direction of J. Howard Horn, general sales manager of the company. Mr. Masters was born in Philadelphia, Pa., and was educated in the schools of East Orange, New Jersey. Previous to going with the National Lock Washer Company he was connected for 12 years with Unger Brothers, Newark, New Jersey.

A new company, which will be known as the Chromium Corporation of America, has been organized to take over the patents of the chromium plating process developed by the Chemical Treatment Company and the Chromium Products Corporation, the latter a subsidiary of the Metal & Thermit Corporation. This new company will have plants and branch offices in most of the leading industrial centers. John T. Pratt, president of the Chemical Treatment Company, will continue in that office and also be chairman of the board of the new corporation, of which Dr. F. H. Hirschland will be president. Dr. Hirschland is also president of the Metal & Thermit Corporation. Vice-presidents in charge of operations are Louis C. Owens, Jr., and Richard Loengard. Dr. Erich A. Beck is also a vice-president.

Clarence G. Stoll, general manager of manufacture of the Western Electric Company, has been elected a vice-president, with headquarters at New York to succeed H. F. Albright, deceased. Mr. Stoll was formerly manager of the Western Electric Hawthorne works in Chicago. He began work with the company 23 years ago as a student engineer in Chicago, and a few months later he was transferred to New York, where he spent some time in the switchboard wiring, tool inspection and engineering departments. His training won for him promotion to head of the apparatus department in New York. In 1907 he returned to Chicago to take charge of apparatus design work. In October of that year practically all apparatus designing was concentrated in New York, with Mr. Stoll as head of the enlarged organization. In 1908 he took over the engineer of methods department of the New York shops and three years later was promoted to acting head of the manufacturing branch, being placed in full charge in July, 1912. The following November he went to Europe to become shop superintendent of the Western Electric Antwerp factory. When the World War broke out, the Belgian factory was closed and in June, 1915, Mr. Stoll returned to America and took over the European automatic department at Hawthorne. In March, 1916, he became superintendent of the operating branch and in October of that year he was given the superintendency of the technical branch. He became assistant general superintendent of Hawthorne in 1920 and was put in charge of all departments at Hawthorne in February, 1923, with the title of works manager.

B. A. Clements has been elected president of the Rome Iron Mills, Inc., with office in New York, to succeed Edward Marshall Zehnder, who died on June 21. Mr. Clements was born in Indianapolis on October 3, 1877, and after attending the public schools of Centralia, Ill., he entered the service of the Illinois Central in 1891 as a messenger boy. He served in various capacities in the operating department until 1906, when he was appointed chief clerk to the operating vice-president. In 1909 he was appointed general agent, reporting to the president. The following year Mr. Clements left the service of the Illinois Central to go as western representative of the Worth Brothers Steel Company, with headquarters at Chicago. In April, 1916, Mr. Clements became vice-president of the Rome Iron Mills, Inc., and remained in this capacity until his election as president.

George Little Fowler

George L. Fowler, consulting mechanical engineer, writer and editor of literary and scientific subjects and a member of the staff of Railway and Locomotive Engineering for the past eight years, died on July 2, following an operation at the Brooklyn hospital, Brooklyn, N. Y.

Mr. Fowler was born at Cherry Valley, N. Y., on August 9, 1855. After his graduation from Amherst College in 1877, he entered the shops of the Miltmore Car Axle Company at Arlington, Vt., where he remained three years, becoming foreman of the shops. He then went to the New York Central as draftsman in the mechanical department, doing both car and locomotive work. He subsequently became chief draftsman of the Industrial Works, Bay City, Mich., manufacturers of excavators and traveling cranes. Later he was draftsman in the car and locomotive department of the Flint & Pere Marquette and was promoted to assistant master mechanic at East Saginaw, Mich. At this place he entered the employ of the A. F. Bartlett Company, manufacturers of sawmill machinery and steam engines, as superintendent. He then went to New York, and after doing some editorial work, served as superintendent of the Peckham Manufacturing Company at Kingston, N. Y., and afterwards became consulting engineer of the firm. Mr. Fowler then opened an office in New York as a consulting engineer and was engaged in this work for the past thirty years, specializing in research work in the field of locomotive design, construction and operation.

In 1887 he began contributing to the pages of the Railroad Gazette, of which the late M. N. Forney was then editor. Later Mr. Fowler became associate editor of that publication and the Journal of Railway Appliances. He was a contributing editor of the Railroad Age Gazette and the Railway Age almost continuously until 1919 when he joined the staff of Railway and Locomotive Engineering. Mr. Fowler was the compiler and editor of the 1906 and 1909 Locomotive Dictionaries. He is the author of The Car Wheel, Locomotive Breakdowns, Emergencies and Their Remedies, and the revision of Forney's Catechism of the Locomotive and compiled the indexes of the Proceedings of the American Railway Master Mechanics' Association and the Master Car Builders' Association.

He was a member of the American Society of Mechanical Engineers, and the American Electric Railway Association, serving on many of the important committees of these societies during the past 25 years.

Some achievements of his original work were the investigations regarding the qualities of steels used in steel tires and solid steel wheels, and the stresses in car wheels. He made the first investigation on the lateral stresses imposed on car and locomotive wheels while in service. He made investigations that resulted in cutting down of the mileage allowance of switching locomotives and conducted investigations of rolling resistances and the gyroscopic action of the motors on electric locomotives.

Mr. Fowler was a liberal contributor of writings, lectures and discussions to scientific, railroad and engineering organizations.

Personal Mention

General

M. D. Stewart has been appointed superintendent of motive power, Lines West, of the Southern, with headquarters at Cincinnati, Ohio.

J. M. Plaskitt has been appointed assistant to the superintendent of motive power, Lines West, of the Southern with headquarters at Cincinnati, Ohio.

S. J. Wagar has been appointed engineer of tests of the Chesapeake & Ohio, with headquarters at Richmond, Va., succeeding J. J. Ewing, deceased.

Arthur C. Peterson has been appointed master mechanic of the Stevens Point Division of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Stevens Point, Wis., succeeding A. L. Fillmore.

Master Mechanics and Road Foremen

J. A. Wilking has been appointed master mechanic of the Southern at Ludlow, Ky.

H. E. Dyke has been appointed master mechanic of the Southern, with headquarters at Selma, Ala.

T. E. Gary has been appointed master mechanic of the Southern, with headquarters at Sheffield, Ala.

M. R. Brockman has been appointed master mechanic of the Southern, with headquarters at Bristol, Va.

W. B. Bunn has been appointed master mechanic of the Southern, with headquarters at Chattanooga, Tenn.

L. C. Shults has been appointed master mechanic of the Southern, with headquarters at Somerset, Ky.

Frank Johnson has been appointed master mechanic of the Southern, with headquarters at Princeton, Ind.

J. L. Cantwell has been appointed master mechanic of the Southern, with headquarters at Spencer, N. C.

J. C. Cain has been appointed assistant master mechanic of the Southern, with headquarters at Birmingham, Ala.

E. C. Gordon has been appointed road foreman of engines of the Toledo Division of the Pennsylvania, with headquarters at Toledo, Ohio.

C. B. Keiser has been appointed assistant road foreman of engines of the Toledo division of the Pennsylvania, with headquarters at Toledo, Ohio.

C. E. Coleman has been appointed assistant road foreman of engines of the Toledo division of the Pennsylvania, with headquarters at Columbus, Ohio.

Lewis Archer has been appointed master mechanic of the Virginia division of the Seaboard Air Line, with headquarters at Raleigh, N. C., succeeding T. M. Price, deceased.

William Hotzfield has been appointed master mechanic of the Duluth-Superior Division of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Superior, Wis., succeeding W. F. Buscher.

M. R. Reed has been appointed acting master mechanic of the Ft. Wayne division of the Pennsylvania, with headquarters at Ft. Wayne, Ind., succeeding O. C. Wright, who has been granted leave of absence.

J. A. Tschuor, master mechanic of the Akron division of the Baltimore & Ohio, with headquarters at New Castle Junction, Pa., has been transferred to the Chicago division, with headquarters at Garrett, Ind., succeeding E. J. McSweeney.

E. J. McSweeney has been appointed master mechanic of the Akron division of the Baltimore & Ohio, with headquarters at Akron, Ohio, succeeding J. A. Tschuor. The headquarters of the master mechanic of the Akron division were formerly at New Castle Junction, Pa.

Car Department

F. J. Gibson has been appointed division car foreman of the Central of New Jersey, with headquarters at Elizabethport, N. J. Mr. Gibson's jurisdiction extends over the Central division east of Phillipsburg, N. J., and the Southern division.

Shop and Enginehouse

A. J. Crandall has been appointed locomotive foreman of the Canadian Pacific, with headquarters at Newport, Que.

G. Kirkcaldy has been promoted to night locomotive foreman of the Canadian Pacific, with headquarters at Farnham, Que.

E. F. O'Connor, formerly air brake instructor of the Southern at Finley shops, Birmingham, Ala., has been appointed general enginehouse foreman, with the same headquarters, succeeding J. C. Cain.

Purchases and Stores

J. L. Higgins, purchasing agent of the Kansas, Oklahoma & Gulf, with headquarters at Muskogee, Okla, has been appointed also purchasing agent of the Midland Valley.

E. V. Purdy has been appointed division storekeeper of the Southern Pacific Lines in Texas and Louisiana, with headquarters at Austin, Texas, a newly created position.

W. H. Taylor has been appointed reporting storekeeper of the Southern division of the Pennsylvania, and M. L. Henderson has been appointed storekeeper at Wilmington, Del.

D. W. Metzdorf, acting general storekeeper of the Alaska Railroad, has been appointed general storekeeper, with headquarters at Anchorage, Alaska, reporting to the general manager.

G. W. Leigh, general storekeeper of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Minneapolis, Minn., has been promoted to assistant purchasing agent and general storekeeper, with the same headquarters, a newly created position.

W. J. Kelleher, assistant to the president and purchasing agent of the Alabama & Vicksburg, with headquarters at New Orleans, La., has been appointed division storekeeper of the Illinois Central, with the same headquarters, succeeding I. S. Fairchild, who has retired on a pension.

E. E. Bashford, vice-president and assistant treasurer of the National Railways of Mexico, with headquarters at New York, will hereafter attend to the purchasing department activities of that company in that city, which work formerly came under the jurisdiction of F. P. De Hoyos, general agent, New York.

Arthur C. Simmons, who has been promoted to purchasing agent of the Chicago Great Western, with headquarters at Chicago, was born on January 1, 1890, at Chicago, and entered railway service in May, 1908, on the Chicago Great Western. His service has been continuous on that road, he having held various positions in the operating, engineering and purchasing departments.

Machine bay in the Angus Shops of the Canadian Pacific, Montreal, Que.